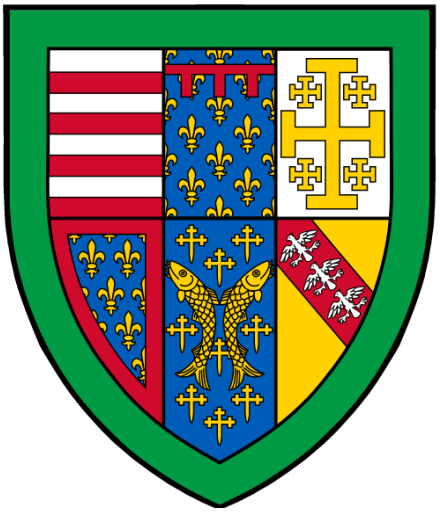
An Investigation of the Relationships between Thinking Style, Participation in Classroom Dialogue and Learning Outcomes – A Study based in Mainland China



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The study reported in this dissertation investigated the relationships between thinking style, participation in classroom dialogue and learning outcomes. Classroom dialogue is a commonly used method for teaching and learning, and ways/strategies of taking advantage of classroom dialogue to optimise learning need to be specified. The study addresses this issue. Talking has traditionally been viewed as the main way of participation in classroom dialogue, and there is evidence for its learning benefit. However, silent participants have largely been overlooked and little is known about the function of listening with regard to learning. There is arguably a need to investigate the effects of both talking and listening on learning outcome. At an individual level, talking and listening do not serve all students equally well and individual characteristics should be considered when studying how students benefit from diverse participation behaviours. Thinking style, one aspect of individuality, is rarely related to participation in classroom dialogue nor has the corresponding learning outcomes been investigated previously: this will be addressed in the study.

The study focuses particularly on high school students in mainland China, a group of people about whom there is relatively little material. A mixed-method research design was adopted, with the quantitative approach dominating. The Thinking Style Inventory - Revised II (Sternberg, Wagner & Zhang, 2007) was used to measure thinking styles. Talking and listening were considered as two forms of participation in classroom dialogue, with systematic observation being employed to collect data on talk and a newly designed questionnaire used to measure listening. Learning outcomes were illustrated through academic achievement and cognitive ability, with the former being measured by final-examination scores and the latter by the Sternberg Triarchic Ability Test (Sternberg, 1993).

A series of statistical analyses were conducted and the results can be summarized as follows. Both talking and listening in classroom dialogue were found to be likely to facilitate academic achievement. Thinking style was significantly associated with participation in classroom dialogue. No relationship was found between thinking style and learning outcomes. Students' thinking styles affected how they benefited from talking and listening, especially in mathematics. This study provides new perspectives on making use of classroom dialogue at both classroom and individual levels.

Declaration

I hereby declare that except where specific reference is made to the work of others, the contents of this dissertation are my own work and have not been submitted in whole or in part for consideration for any other degree or qualification in the University of Cambridge, or any other university. This dissertation contains fewer than 80,000 words including appendices, bibliography, footnotes, tables and equations and has fewer than 150 figures.

Acknowledgement

Finally, in a night with heavy rains and high winds, I have reached to point of finishing the last few sentences in writing this acknowledgement. The whole journey, however, unlike the whether outside, was pleasant and fruitful. I am truly indebted and thankful to many for the completion of this PhD.

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The past four years in Cambridge have been the most joyful days in my life. I sincerely owed to have that precious experience!

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Chapter 1 Introduction

Classroom dialogue, defined as communication in classroom settings where "one individual addresses another individual or individuals and at least one addressed individual replies", is a commonly used method for learning and teaching (Howe & Abedin, 2013, p. 326). How to make efficient use of classroom dialogue to learn has been a concern in both academia and practice (Resnick, Asterhan, & Clark, 2015). As reviewed in Chapter 2, talking is the focus of research in relation to classroom dialogue, and is most often viewed as a major way of participating in class (Rocca, 2010). Through talking students are expected to gain access to diverse ideas, gain practice in critical thinking and deepen understanding (Mercer & Dawes, 2014). This may consequently be beneficial in terms of achieving satisfactory learning outcomes (Dallimore, Hertenstein, & Platt, 2010; Handelsman, Briggs, Sullivan, & Towler, 2005), which results in wide encouragement for getting as many students as possible to talk in class (Littleton & Mercer, 2013; Weaver & Qi, 2005).

Although its importance is acknowledged, talking is not the only way of participating in classroom dialogue, for students can also be involved through attentive listening. This is especially true when I refer to my personal experience of growing up and being educated in mainland China. With 50 or more students sharing one 40-minute lesson, I disliked talking a great deal in class and spent most of the time listening to the teacher's course delivery. It turned out that this reluctance to talk did not prevent me from achieving high academic scores, as I constantly ranked in the top three students in examinations. Many Chinese students are very similar to me, listening to learn. Then I came to Cambridge to take the MPhil and PhD courses, and joined the academic group studying classroom dialogue. I found that silent participants seemed to be largely overlooked in the study of classroom dialogue and there is little material about how attentive listening affects learning. I felt that there is a need to address this gap and I decided to focus on classroom dialogue for the PhD research, taking account of both talking and listening. Both participatory methods have been included in my study, and testing their relationship with learning outcomes has served as one of my research purposes.

Moreover, talking and listening may not facilitate the learning of all students equally well (Clark, 2015), with some students being more suited to learning through talking in class while others are more suited to involvement through listening (O'Connor, Michaels, Chapin, & Harbaugh, 2017). It is necessary to consider individual characteristics in studying students' participatory behaviour in classroom dialogue and how they benefit from diverse participation. As detailed in Chapter 2, among the many possible ways of characterizing individual difference,

thinking style, that is, people's typical ways of processing information, appears to be among the most reasonable candidates and very few previous studies have provided evidence about how it relates to participation in classroom dialogue and the corresponding learning outcomes (Howe & Abedin, 2013). Students are characterized by varied thinking styles, and accordingly they may approach learning tasks diversely, choosing different methods or strategies (Cheng, Andrade, & Yan, 2011). My MPhil study found that students characterized with different thinking styles prefer to use different strategies/ways to participate in classroom dialogue, with some talking and others listening. As a learning method, the goal for increasing participation in classroom dialogue should help with learning. However, there is little research involve learning outcomes when studying the relationship between thinking style and participation in classroom dialogue. I aimed to address this issue in my PhD research. I considered that is would be interesting to explore how this diversity in thinking style affects students' classroom participation and the learning outcomes achieved from talking and listening.

It is undeniable that sociocultural and educational contexts need to be considered when addressing the questions. Most studies on classroom dialogue have been concerned with primary or secondary school students up to the age of about 16 years. Little attention has previously been paid to 17- to 19-year-olds (see Howe & Abedin, 2013). From my personal experience, the final years of schooling are crucial, especially for Chinese students, as performance here determines whether or not they can be admitted to a prestigious university. I thus added in this respect by focusing on high school students in mainland China. As detailed in Chapter 3, the study took a pragmatic stance, and a mixed-methods research design was correspondingly adopted. This said, the quantitative approach played the more dominant role in the study and was used to investigate the general relationship between thinking style, participation in classroom dialogue and learning outcomes. Thinking styles were measured with the help of the Thinking Style Inventory-Revised II (TSI-RII, Sternberg, Wagner, & Zhang, 2007). The data concerning talk in classroom dialogue were collected through systematic observation and video. An instrument revised from my MPhil study was used to code students' talk. A newly designed self-report questionnaire was used to measure listening, as very few tools exist and it is hard to observe students' performance when they remain silent. Learning outcomes were demonstrated through academic achievement and key cognitive abilities, which were measured through examinations and the Sternberg Triarchic Ability Test, respectively (STAT, Sternberg, 1993). Subsequently, a qualitative approach played a supplementary role in clarifying the underlying mechanisms within the relationships and how thinking style takes effect. Ethical issues were considered when designing the research.

Obtaining informed consent from relevant participants, allowing them the right to withdraw, and protecting their autonomy and confidentiality were essential steps to be taken into consideration (BERA, 2011).

Data collection was followed by data analysis and reporting of the results, as presented in Chapter 4. Thinking style, participation in classroom dialogue (including talk and listening) and learning outcomes (including academic achievement and cognitive ability) were analysed separately first. After gaining a basic understanding of the data, the relationships between each pair of variables were examined, that is participation and outcome, thinking style and participation, and thinking style and outcome. A moderation analysis was also conducted to examine whether and how students' thinking styles affected the ways they benefited from diverse participation behaviours in classroom dialogue. Thematic analysis of the interview data played a subordinate role in understanding the above relationships. A justification for the findings obtained, including those concerning the separate key variables and their relationships is presented in Chapter 5, and I will show how the analyses addressed the specific research questions, which had been presented in Chapter 2. Finally in Chapter 6, the findings are summarized, with an awareness of the limitations that emerged from my PhD study. Nevertheless, there are contributions to the field of thinking style, classroom dialogue and learning, based on which implications for educational practice and future research were highlighted.

This study aimed to provide a new perspective in order to facilitate understanding of students' participation in classroom dialogue, its function and its suitability, and then help more students take advantage of classroom dialogue in order to learn. Classroom dialogue can be made use of in different ways, not only through talking: listening carefully to others is another way of participating in classroom dialogue. This is particularly true when dialogue proceeds in a whole-class teaching environment, where students have limited opportunities to communicate fully. At the individual level students are characterized according to different thinking styles, on the basis of which they consciously choose their preferred strategies and methods of learning. Acknowledging their thinking styles may help students make better use of classroom dialogue in a whole-class context, and achieve satisfactory learning outcomes through participating in the dialogue.

Chapter 2 Literature review

This chapter outlines the theories and empirical studies underpinning my empirical research. It starts with the introduction of a learning method that has been frequently explored in research - classroom dialogue. Examining classroom participation is one essential aspect of research into classroom dialogue. I define classroom participation as an activity in which talk and listening are viewed as its two essential forms. Then, the way in which Chinese students participate in classroom dialogue is introduced as I based my study in mainland China.

Regarded as a learning method, there is inevitable discussion of whether classroom dialogue benefits students' learning. Usually basing their work on the socio-cultural theory proposed by Vygotsky (1978), many scholars have asserted that participation in classroom dialogue facilitates learning. In particular, students increase their thinking and understanding through talk, which calls for their active involvement in classroom dialogue. Reflecting on this claim, I argue that students who are involved in dialogue through attentive listening may also be likely to learn well. This requires considering the functions of both talking and listening in learning.

Students vary in terms of their involvement in classroom dialogue, and talk and listening may not serve all students equally well. Accordingly, I suggest that whether and how participation in classroom dialogue benefits learning may depend on students' individual characteristics. Finding a factor, which moderates the relationship between classroom participation and learning outcome, becomes necessary. Many factors, such as gender and ethnicity, have been called upon, yet they cannot explain this phenomenon fully. Thinking style, as proposed by Sternberg, is identified as useful for developing an understanding the manner in which students benefit from classroom dialogue. This is a rather new perspective, with little material existing which describes how thinking style affects the relationship. Thus the literature on how thinking styles relate to participation and learning outcomes is reviewed in the hope of getting some clues. Based on a summary of limitations identified in previous studies, research questions are proposed to investigate the relations between each pair of the three critical variables (i.e. thinking style, participation in classroom dialogue, and learning outcome), and second to explore whether or not thinking style moderates the relationship between participation in classroom dialogue and learning outcomes. Finally, there is an attempt to understand the above relationships from students' perspectives.

2.1 Classroom dialogue

Classroom dialogue is a frequently explored method for teaching and learning (Howe & Abedin, 2013), and it is viewed as a main indicator of interaction between teachers and students, and between students themselves in classroom settings (English, Hargreaves, & Hislam, 2002; Wells & Arauz, 2006). Numerous studies have been conducted on classroom dialogue, especially in the US and the UK. Scholars define classroom dialogue in diverse ways in accordance with background theories and research objectives (Howe & Abedin, 2013). There is no clear consensus about the many definitions, and scholars have been seeking one that could incorporate typical dialogic behaviours. As stated in the introduction, I use the definition proposed by Howe and Abedin (2013), namely that classroom dialogue refers to verbal communication in classroom settings where by "one individual addresses another individual or individuals and at least one addressed individual replies" (p. 326). It is noticeable that the students who are addressed can reply after an interval as long as the class does not move on to another topic or question (Howe & Abedin, 2013). This definition is clear for use when searching articles and identifying dialogic behaviours in empirical studies (Howe & Abedin, 2013), and has won wide recognition (Pehmer, Alexander, & Seidel, 2015). Howe and Abedin (2013) recognized that some scholars use narrower definitions, but felt that a narrower definition would not adequately represent the field. Thus the broad definition presented above is most appropriate for use in my study.

In an ideal state of classroom dialogue, individuals not only respond to previous inquiries or utterances, but also initiate responses (Bakhtin, 1986). Students and teachers actively comment and build on each other's ideas, and then explore knowledge co-constructively (Alexander, 2004; Mercer, Hennessy, & Warwick, 2010). As proposed by Alexander (2008, p. 107), dialogic learning aims to achieve the following goal, namely, that "students achieve common understanding through structured, cumulative questioning and discussion which guide and prompt, reduce choices, minimize risk and error, and expedite 'handover' of concepts and principles". Yet in practice, due to the rapid pace of lessons and soliciting of correct answers, full sharing and exploration of ideas is less commonly observed (Mercer et al., 2010; Nystrand, 1997).

A three-step pattern, initiation-response-feedback (IRF), as illustrated by Sinclair and Coulthard (1975), is taken to be the dominant pattern within classroom dialogue (Alexander, 2001; Liu, 2008; Myhill, 2006; O'Connor & Michaels, 2007). Initiation means that one individual, usually the teacher, starts a dialogue by posing a question or raising a topic.

Teachers' initiations can be divided into two main types: one type has definite answers (e.g. '26 plus 17 equals?'); the other type asks for students' opinions and does not have fixed answers (e.g. 'Could you explain your feelings about the musical called Phantom of the Opera?'). Then, responses are given, usually by students. Finally, initiators provide feedback upon these responses, which may be further divided into short judgments (e.g. 'good', 'interesting') or detailed evaluations (Berry & Kim, 2008; Schwab, 2011).

Teacher-student interaction and student-student interaction are the two main types of classroom dialogue, and they have both been studied extensively (Howe & Abedin, 2013). Yet talk among students when no teacher involves is less common in classrooms, and has typically not been regarded to facilitating productive exchanges of views when it does take place (e.g. Galton, Hargreaves, Comber, Wall, & Pell, 1999). Also, small-group work is rarely seen in Chinese classes, as there are so many students within one class and it is difficult to group students effectively (Fung & Howe, 2014). It is also hard to track each student's contributions in small group dialogue when large numbers are involved. Thus my research focuses only upon teacher-student interaction in whole-class contexts.

Whole-class dialogue is characterized by a quantitative imbalance of contributions, and a lack of reciprocity in the exchanges (Vande Veen & Van Oers, 2017; Flanders, 1970). In real practice, dialogue is usually dominated and led by teachers, and proceeds in an orderly manner (Lin, 2007). As stated by Molinari, Mameli and Gnisci (2013, p.414),

> *Teachers control the children's participation in the discourse by initiating most linguistic exchanges, assigning turns, and having the right to the third move; teachers have didactic and pedagogical purposes that need to be pursued in the discourse; teachers assume the role of primary knower and direct the discourse in a pre-determined direction.*

Teachers' talk often occupies most of the class time, with only one-third of talk typically contributed by students (Fritschner, 2000; Wade, 1994). In whole-class interaction, unlike small-group talk, with the constraints of time and lesson plans, the possibilities for each student to talk are limited (Cook, 1989), and the time allowed for students to reply is short (Hardman, Smith, & Wall, 2003; Lin, 2007; Mercer, 2008; Myhill, 2006). Moreover, students are expected to give pre-determined answers as most of the teachers' questions are oriented and focused (Lin, 2007; Lyle, 2008).

2.2 Participation in classroom dialogue

Examining classroom participation is one essential aspect of research into classroom dialogue (Resnick et al., 2015; Vande Veen & Van Oers, 2017). Promoting participation is an attempt to make effective use of classroom dialogue in learning and thinking (Dallimore et al., 2004). In this section classroom participation is defined, with both talking and listening/attentive silence being considered. Then there is an introduction to how students in mainland China typically engage in classroom dialogue.

2.2.1 A way to define participation

Participation is a ubiquitous idea in education, yet it is rarely defined and there is seldom any discussion of whether a particular behaviour should be counted as active participation. Rocca (2010) has systematically reviewed research articles on classroom participation. A popular and widely cited article by Karp and Yoels (1976) is viewed as a starting point for the study of classroom participation. Over the many years of study, some scholars (e.g. Dancer & Kamvounias, 2005; Fritschner, 2000) have indicated that anything from simply attending class to oral presentation should all be counted as participation; others (e.g. Burchfield & Sappington, 1999) restrict participation to those unsolicited responses volunteered in a classroom setting. Nevertheless, one common theme is that verbal contribution or talk[1] is viewed most often as an indicator of participation and has broad application in both research and educational practice (Rocca, 2010).

Verbal participation can appear in different forms, including students' questions and comments (Fassinger, 1995), and can take only a few seconds or last for an extended period of time (Cohen, 1991). According to the categories listed in Jones and Gerig (1994), raising hands to answer questions voluntarily, raising hands to initiate a comment or question, and calling out "a response without waiting to be called on by teachers" (p. 173) reveal students' willingness to participate. Jones and Gerig viewed that being called on by teachers when not putting hands up did not show students' intention. Similarly, giving answers in turn was not treated as participation behaviour, as students have to answer questions when it is their turn, no matter whether they are willing or not. One assumption underlines my study is that students have different individual characteristics, based on which they will make their own choices about whether or not to answer questions, and how to make verbal contributions. If we accept

[1] I used the term 'talk' rather than 'speaking' or 'speech' for the reason that 'speaking' or 'speech' is used to describe notions of sound production, while 'talk' emphasizes interaction and communication (Mercer, 2008). 'Talk' is in alignment with the definition of classroom dialogue and thus is used in my study.

this perspective, participation behaviours that show students' willingness should be my focus, and therefore being called upon when they do not raise hands and giving answers in turn are excluded.

Apart from engaging in talk, students can also be involved in classroom dialogue through listening (Clark, 2015; Schultz, 2009). Listening is defined in the Oxford Dictionary as "giving one's attention to a sound" or "making an effort to hear something". In classroom settings, listening requires students to block distracting things and noise, including those arising from both outside and inside, and focusing on specific stimuli, such as teachers' talk and course content; then being able to paraphrase, analyse and organize information in their minds, abilities which are expected to aid memorization and understanding (Schultz, 2009). The Common Core State Standards for Language Arts (2013. p. 7) recognize the role of listening in classroom participation and its importance as a skill that students must master to become ready for college and their subsequent careers:

> *Students must learn to work together, express and listen carefully to ideas, integrate information from oral, visual, quantitative, and media sources, evaluate what they hear, use media and visual displays strategically to help achieve communicative purposes, and adapt speech to context and task.*

If students listen carefully to others' talk, take notes, memorize knowledge and think critically, they make use of classroom dialogue to learn and should arguably be counted as active participants even though they do not contribute to talk (Clark, 2015; Schultz, 2003, 2009; Wade, 1994). What may be renamed as 'attentive silence' (a practice that will be followed in this thesis report) has been identified in many studies (e.g. Fritschner, 2000; Howard & Henney, 1998; Howard, James, & Taylor, 2002) – a handful of students play the role of active talkers, "while the majority engage in 'civil attention', paying sufficient attention to know when to nod, to laugh where appropriate, or otherwise to appear attentive without risking too much involvement" (Weaver & Qi, 2005, p. 571). Recently, more studies have recognized attentive silence as a form of classroom dialogue participation and have called for attention to be paid to silent participants (e.g. Clark, 2015; O'Connor et al., 2017; Schultz, 2003). In my study, attentive silence is seen as equivalent to listening, and both expressions are used in this paper. This usage takes account of the school contexts in mainland China, where almost all students behave properly in classes, with no one sleeping or doing something irrelevant to course content. When a student chooses to remain silent and not to answer questions, it is very likely

that he/she is listening to others' talk. Thus listening and attentive silence seem indicate same behaviours in the school context of my study. Moreover, 'attentive silence', 'listening', and 'silent participants' are interchangeably used in other studies. One representative is a very recent study, O' Connor et al (2017), which probably reflects the current trend in the field of classroom dialogue. They state that "it is not unreasonable to conclude that the silent students may have been active listeners…students who listen attentively but do not speak derive the same benefits from dialogic interaction as their vocal classmates" (p. 283). According to O' Connor (2017), keeping silent is a common phenomenon in classrooms and is what can be observed externally. An attempt to understand silent participants is increasingly highlighted in the field of classroom dialogue. To interpret the phenomenon from students' perspectives, those who remain attentively silent may listen carefully to course content. This is probably a reason why people keep the two expressions and use them interchangeably in articles.

Participation includes paying attention to course content and following teachers' directions; more importantly, it is referred to as "an active, relational, and interpretive process that is focused on making meaning" (Shultz, 2003, p. 8). To be more specific, a definition proposed by Schultz (2009, p. 85) is appropriate, in which participation in classroom dialogue is referred to as "verbal and nonverbal contributions to ongoing classroom interactions." Talk and listening/attentive silence are therefore the two main forms of participation that will be discussed in this thesis.

Classroom participation is frequently studied with respect to both its frequency and its quality (Rocca, 2010). While a review conducted by Loftin, Davis and Hartin (2010) identifies numerous subtypes of classroom participation, including negative/positive participation, and passive/spontaneous participation, frequency and quality emerge as the types most commonly referred to (see also Rocca, 2010). Many official agencies use these two criteria for the assessment of students' performance in class. For instance, an agency named the Assessing Discussion Board of the University of New South Wales (2014, p. 4) has stated that students' contributions to class dialogue should be graded according to "1) frequency, and 2) depth and quality". Counting the number of instances of participation is employed most frequently, probably because it is quantitative in nature and easy to register reliably (Rocca, 2010). Quality of talk is subjective and presents more of a measurement challenge, nevertheless it is argubly just as important in terms of students' learning experiences (Rocca, 2010). Thus I further divide each form of participation into frequency and quality (i.e. frequency and quality of talk, and frequency and quality of listening).

2.2.2 Classroom participation in mainland China

My study focuses on students in mainland China. There is a stereotype of Chinese students that portrays them as quiet and less talkative in classroom dialogue (Cheng et al., 2011). They are thought usually to show little willingness to express their opinions, raise questions with teachers, or influence their peers through discussion and argument (Kennedy, 2002). They are believed to memorize content delivered by teachers passively, and exhibit a high level of compliance and obedience (Olaussen, 1999). Moreover, when Chinese students contribute to classroom dialogue, they are said often to replicate the content of textbooks or the material delivered by teachers, while exhibiting lower levels of reasoning (Gan, 2009; Kember & Watkins, 2010). Purdie and Hattie (1996) have summarized the characteristics of classroom participation among Chinese students: lack of talk, lack of questioning, no indication of understanding or lack of understanding, and lack of critical thinking. If true, this is probably influenced by the Confucian cultural background, and Chinese national characteristics involving restraint and a lack of willingness to express opinions (Cortazzi & Jin, 1996; Ho & Crookall, 1995; Littlewood, 1999). Some other scholars attribute this phenomenon to the educational system in China, which is examination-oriented and places less emphasis on classroom talk (Biggs, 1996).

With the rapid development of mainland China (Lo, 2013), the Chinese government and Chinese educators have become convinced that the situations described above repress students' cognitive development and cannot meet the country's socioeconomic needs (Ministry of Education of People's Republic of China, 1999). The Chinese education authority has launched an educational reform, referred to as 'character-building education', in which increasing students' classroom participation has been particularly emphasized (Ministry of Education of People's Republic of China, 1999). According to the new policy, heuristic ways of teaching are highlighted and classroom dialogue is a method that teachers are encouraged to use more in teaching and learning. Students are stimulated to think independently, analyze problems and express their ideas freely. Implementation of the policy is expected to foster students' scientific spirit, reasoning ability and innovation (Zhou & Zhu, 2007, p. 31).

> *To change curriculum implementation from an over-emphasis on receptive learning, rote memorization and repetitive mechanical training to students' active participation, motivated inquiry and hands-on experiences, and develop learners' capacity for collection and processing information, acquiring new knowledge, problem-solving and communication-cooperation.*

Since launching the new policy, the official data published by the Chinese government have shown that students' classroom participation has improved dramatically, especially in primary and secondary schools (Ministry of Education of People's Republic of China, 2006). On average, 75.9 per cent of students demonstrated participation in classroom dialogue, and as few as 0.7 per cent of classes were viewed as lacking teacher-student interaction.

Some scholars have recently been attempting through their empirical studies to build an alternative image of Chinese learners and to investigate how they currently participate in classroom dialogue (e.g. Cheng et al., 2011; Clark & Gieve, 2006; Grimshaw, 2007; Holliday, 2005; Li & Ni, 2011; Song, 2015). My MPhil research, published in Song (2015), involved observing 186 secondary students (grade 9) in a medium-sized city in mainland China. I found that the frequency of talk was generally low and most students tended to remain silent during classroom dialogue, a small number of students participated actively and contributed a great deal. As regards participation quality, the accuracy rate of students' answers was high. A positive phenomenon was that students' contributions did not merely replicate course content or display recitation of textbooks. What is more, many of the participants demonstrated reasoning in their talk. Similar results were found in a study conducted by Li and Ni (2011). They examined the impact of the Chinese education reform on students' learning practice in primary mathematics. The study involved 58 classes from 20 schools, which had utilized the reformed curriculum for more than five years. Results showed that, compared with conventional classes, dialogue in the reformed classes was more likely to include the procedures used by students to reach an answer, along with explanations and evaluations. As indicated by the above, positive changes in classroom practice were seen to have resulted from implementation of the reforms, especially in terms of the quality of talk (Li & Ni, 2011). To summarize, some Chinese students made sensible use of classroom dialogue and showed reasoning in classroom participation, yet it is undeniable that often were less talkative and the overall frequency of each student's participation remains low.

2.3 Relating participation in classroom dialogue to learning

Being a learning method, the ultimate goal of involvement in classroom dialogue is that it should help with learning. The relationship between participation in classroom dialogue and learning outcome is probably one of the most popular topics in the educational field, and is "essential for the advancement of evidence-based academic understanding and the innovation of classroom practices" (Vande Veen & Van Oers, 2017, p. 2). Yet scholars' conclusions

regarding whether and how these two variables related are rather varied (see Howe & Abedin, 2013; Resnick et al. Rocca, 2010). Before relating classroom participation to learning, it is necessary to conceptualize learning outcome first.

2.3.1 Learning outcome

Learning outcomes are frequently the focus of research concerning classroom dialogue, and positive outcomes are taken as an ultimate goal of effective classroom interaction (Cazden, 2001). A satisfactory learning outcome is responsible for both quantitative increases in the assimilation of information, and qualitative advances in transforming simplistic thoughts into more complex and mature understanding (Gijbels, Donche, Richardson, & Vermunt, 2014). There are generally two traditions in the field of learning outcomes research: one treats learning as a process of acquisition, while the other takes an involvement perspective (James & Brown, 2005). In the tradition of acquisition, knowledge can be "accumulated, gradually refined, and combined to form ever richer cognitive structures" (Sfard, 1998, p. 5), and it is a thing to be possessed. This indicates that students achieving good learning outcomes should be those who have mastered and acquired knowledge. By contrast, studies that align with the involvement tradition claim that learning outcomes are evaluated by whether or not a person displays active involvement in certain kinds of activities (Sfard, 1998).

Of the two traditions, the acquisition approach is more prevalent than the involvement one, especially in school contexts (Daugherty, Black, Ecclestone, James, & Newton, 2008; James & Brown, 2005). Moreover, the learning environment in China places more emphasis on competition and achievement than on process (Vermunt, Bronkhorst, & Martínez-Fernández, 2014). Thus for this study, it is considered to be more appropriate to base the work on the acquisition tradition.

2.3.1.1 Academic achievement

Measuring academic achievement is probably the most widely used method of evaluating learning outcomes, both in educational research and educational practice (Boaler, Wiliam, & Brown, 2000; Gijbels et al., 2014; Nystrand, Wu, Gamoran, Zeiser, & Long, 2003). Academic achievement refers to how much a student has learned in school and the extent of his/her knowledge about a specific curriculum topic (Salkind, 2007). According to Riding (2002, p. 4), academic achievement is "the degree of learning that is usually manifested in terms of tests and examinations", one essential requirement of which is memorizing information (Kember & Watkins, 2010). Achievement is usually assessed by means of quizzes, criterion referenced

tests, and standardized examinations or essay tests, whose marks and rankings can be used to differentiate students' learning outcomes (Fogarty & Pete, 2005). The wide use of academic achievement in assessing learning outcomes may be due to the fact that it saves time and provides easy access when collecting data. Moreover, academic achievements, especially those assessed by standardized examinations (e.g. A-level examinations in UK, college entrance examinations in China, and SAT in America) are widely recognized as significant, and have important consequences as regards university entrance and future employment. Thus it is necessary to consider academic achievement when evaluating learning outcomes.

2.3.1.2 Cognitive ability

It seems, however, to be insufficient to evaluate students' learning merely through academic achievement. "It is important to make a difference between learning results and exam achievements. Too often the latter only reflects a small portion of the former" (Vermunt, 2005, p. 209). As stated by Sternberg (1997, p. 12),

> *People who have a success in learning are those who have managed to acquire, develop, and apply a full range of intellectual skills, rather than merely relying on the inert intelligence that schools so value. These individuals may or may not succeed on conventional tests, but they have something in common that is much more important than high test scores. They know their strengths; they know their weaknesses. They capitalize on their strengths; they compensate for or correct their weaknesses.*

It is claimed that many school tests and examinations pay limited attention to students' capabilities in relation to critical thinking and deep processing of information (Gijbels et al., 2014; James & Brown, 2005; Stevenson & Palmer, 1994; Vermunt, 2005). For instance, according to the ESRC's Teaching and Learning Research Programme (TLRP), learning outcomes will appear in seven main areas: attainment, understanding, creativity, using, higher-order learning, disposition and membership. It was found that creativity, using knowledge to practise, and higher-order learning were not clearly identifiable in assessment papers (see James & Brown, 2005). Furthermore, Zhang (2004) collected data on students' academic achievements in 16 subjects. She found that scores for physics, chemistry, art and design, music and biology were not significantly related to analytical ability; the score for music did not show a significant relationship with creative ability. These examples imply that academic

achievement cannot fully account for learning outcomes, and it is necessary also to evaluate key abilities (Deng, 2009; Stevenson & Palmer, 1994).

Ability refers to how well one can perform with a task (Renzulli & Dai, 2001; Sternberg, 1997), and usually means the level of intelligence when studied in the field of psychology (Lohman, 1997). Ability is traditionally assessed by IQ tests, which makes measurement easy to conduct and can be scientifically convincing (Devlin, Michael, & Kathryn, 1997; Sternberg, 1985). However, there has been criticism that IQ tests are over-simplistic and more often only measures analytical ability, while minimizing creativity, character and practical ability (Sternberg, 1985). Sternberg (1985) proposed a theory named the Triarchic Theory of Intelligence, in which he asserted that intelligent behaviour is how well an individual deals with environmental changes throughout their lifespan, and involves adapting to the environment, changing the environment, and selecting a better environment. Based on this theory, analytical/reasoning, creative and practical abilities are viewed as the three main components of intelligence. 'Analytical ability' emphasizes one's capability in critically processing information; 'creative ability' relates to how individuals take advantage of pre-existing knowledge to learn new information and deal with novel situations; 'practical ability' refers to one's capability in applying knowledge to solving problems in practice. According to Sternberg (1993, 1999), analytical ability is represented through analysing, judging, comparing and contrasting, and evaluating; creative ability is involved in creating, inventing, discovering and innovating; practical ability is employed in applying, using, implementing and putting things into practice. Sternberg (1997) contends that what makes a difference in determining learning outcomes depends on how students use and balance these three types of ability. Sternberg believes that people's cognitive abilities are not innate, but can be developed through training and learning.

In the Chinese educational context, increasing students' analytical, creative and practical abilities has been emphasized by both the government and educators, and set as an essential learning goal. As introduced in Section 2.2.2, the Chinese educational authority has launched the 'character-building' educational reform, designing new curricula and encouraging classroom participation. The objectives of this reform include cultivation of creative spirit, capability of practice and scientific competencies, the facilitation of students' analytical ability, and the development of independent, reflective and critical thinkers (Deng, 2009; Zhou & Zhu, 2007). Analytical, creative and practical abilities have been recognized both in research and practice. I thus considered these three aspects of abilities when evaluating students' learning

outcomes. Also, development of cognitive abilities has been viewed as one of essential goals of learning, and thus in my study, cognitive ability is assessed to reflect students' learning outcomes.

2.3.2 The contribution of classroom talk to learning outcomes

One widely acknowledged proposal is that contributing through talk to classroom dialogue has a positive effect on learning (Christensen & Hansen, 1991; D' Ambrosio, Johnson, & Hobbs, 1995; Grouws, 2004; Koichu, Berman, & Moore, 2007; Resnick et al., 2015). It is considered that the more a student talks in public, the better he/she will learn, while, on the contrary, students who play a less active role in classroom talk will have a lower level of learning (Bonwell & Eisen, 1991; Dallimore et al., 2010; Nystrand, 1997). This claim is usually warranted with reference to the work of Vygotsky (1978), who proposed a socio-cultural theory bridging the relationship between thought, action, communication and culture. The theory's basic assumption is that thought or mental activities are situated in cultural, historical and institutional settings (Wertsch, 1993), and learning involves a transition from interpsychological to intrapsychological functioning (Wertsch, 1993). Vygotsky's ideas have been taken up, tested and developed in a variety of ways over the past 30 years. The socio-cultural perspective has been applied widely in educational research and is now dominant in the West (Mercer, 2008).

Many scholars have put forward persuasive arguments for the importance of classroom dialogue in developing students' reasoning and thinking, and in understanding curriculum subjects, especially mathematics and science (e.g. Alexander, 2001; Mortimer & Scott, 2003; Resnick et al., 2015). It is explained that through dialogue, students not only embrace diverse ideas, but also "gain practice in thinking through problems and organizing concepts, formulating arguments and counter arguments, and responding thoughtfully and critically to diverse points of view" (Davis, 1993, p. 63; Mercer & Dawes, 2014). This is assumed to facilitate learning achievement (Handelsman et al., 2005; Weaver & Qi, 2005). In particular, verbal participation, that is talk, has been highlighted as a key medium in the development of thinking and knowledge acquisition, as cited in Littleton and Mercer (2013, p. 98):

> *Language plays an important role, as it is a medium for transmitting knowledge from one mind to another… Individuals in a group can also gain new levels of understanding through co-construction, if they jointly construct new explanations*

> *with their partners…It will promote their metacognitive awareness of how they talk and reason together.*

Influential as the socio-cultural theory may be, it is insufficient merely to rely on its conceptual elegance or intuitive appeal; empirical support is needed (Mercer, 2008). It is acknowledged, even by those who support Vygotsky's theory, that there is only a small number of empirical studies with positive results (Mercer, 2008). Nevertheless, empirical evidence does exist that demonstrates that participation in classroom dialogue is associated with gains in learning outcomes, in terms of both specific learning skills and general academic achievement (see Resnick et al., 2015).

For instance, the work of Brown and Palincsar (1989) was a significant early contribution to the above claim, showing a positive relationship between talk and increases in a specific learning skill, reading comprehension. The study was conducted in a primary school, and the teachers adopted a reciprocal teaching method, which aimed to encourage students to participate, that is talk actively and critically in class; in particular, students were prompted to contribute more by questioning, clarifying, summarizing and predicting. Brown and Palincsar designed a series of specific dialogic strategies for both teachers and students. Results indicated that students made expressive gains in reading comprehension, and students who achieved a higher level of talk were more likely to understand reading content better.

More recently, Leach, Ametller, Hind, Lewis and Scott (2003) conducted an ESRC-sponsored project, 'Evidence-based practices in science education'. The team worked with science teachers in nine local secondary schools in the design of three short teaching interventions, which were aimed primarily at students aged between 11 and 14 years. The interventions helped teachers adopt a dialogic teaching approach, including leaving time for students to express their ideas, helping them clarify ideas, extending their ideas and assisting them in exploration. They chose a number of classes in which to conduct the intervention, while others were used for comparison. Students' learning outcomes were measured through diagnostic tests. The team found that students in the classes in which the intervention took place, namely those in which students were supported to talk more in class, generally had higher learning outcomes, particularly in relation to questions probing understanding. It should be noted that the learning outcomes were not measured by normal academic tests, but by diagnostic tests designed particularly for the project. This might have biased the results towards the intervention group.

A study conducted by Nystrand (1997) provides further positive evidence. Nystrand collected data from students aged about 16 years and then analysed these data qualitatively. He found that there was a close association between high-quality dialogue and student achievement. He noted that the talk that facilitated learning did not simply consist of statement of facts or recall of information, but involved those aspects that could improve understanding and thinking, such as explanation or hypothesis, which in his view constituted high-quality talk. A study carried out by Dallimore et al. (2010) with university students obtained similar results. Dallimore et al. collected data during 14 sections of an accounting course specially designed for university undergraduates. Participation referred only to verbal contributions, and was assessed through the use of questionnaires, in which a 5-point Likert-type self-evaluation ranging from 'absent' to 'making outstanding comments' was used to grade students' participation performance. Course grades were collected from the lecturers afterwards. Dallimore et al. reported significant positive associations between participation frequency and learning outcomes. However, one should be cautious when drawing conclusions as the researchers found that students who talked frequently had prepared well for class, and one higher academic achievement may be partially due to the students' careful preparation and not just to their active engagement in talk.

An intervention reported in Mercer and Littleton (2007) is seen as one of the most convincing studies supporting Vygotsky's socio-cultural theory and showing that participating in classroom talk enhances learning outcomes (Mercer, 2008). The project lasted for a few months, targeting students between 7 and 11 years of age. Researchers working with teachers planned the intervention (Dawes, Mercer, & Wegerif, 2003), aiming to engage more students in classroom dialogue, particularly through exploratory talk. Exploratory talk referred to a specific kind of dialogue in which "speakers share relevant knowledge, challenge ideas, evaluate evidence, consider options, and try to reach agreement in an equitable manner" (p. 95). The intervention was then implemented in British primary schools. Students in the experimental schools were matched with those of the same age in other local schools, which taught the same curriculum using established methods. In the experimental classes, students were scaffolded to share information, challenge ideas, evaluate opinions and explore knowledge. In order to investigate whether participation in classroom dialogue helps with reasoning and mastery of course content, researchers assessed learning outcomes using both the Raven's Progressive Matrices test and standard academic tests. Results showed that students in the experimental classes used more exploratory talk than those in the control classes. Groups who contributed more and a higher level of talk solved Raven's problems more

successfully, indicating that reasoning ability can be improved through classroom participation. Moreover, students in the experimental classes obtained higher scores on the science and mathematics tests. The researchers then concluded that participating in classroom dialogue facilitated learning. Effective as it may be, it should be acknowledged that this kind of dialogic teaching is exceedingly rare in classrooms (Cazden, 2001; O'Connor et al., 2017).

To summarize, there is evidence that talking in classroom dialogue helps with learning. Due to the potentially greater opportunity for achieving good outcomes, many scholars (e.g. Dallimore, Julie, & Marjorie, 2006; Dallimore et al., 2010; Mercer, 2000; Weaver & Qi, 2005) have advocated that students should participate actively and, in particular, make more verbal contributions, in classroom dialogue. It is suggested that in order to support the learning of all students equitably, teachers should encourage most or all students to talk (see O'Connor et al., 2017) and ideally "contributions should be equalized across the student body" (see Howe & Abedin, 2013, p. 340). Students who play a less active role in talking should be called upon by teachers (Wade, 1994). However, there are several points should be noted before taking this for granted. Firstly, most studies have focused on primary or secondary school students, while there is relatively little material on older students, such as those in high schools. Secondly, many of the studies that show a contribution of talk to learning have adopted an experimental approach or conducted interventions, and the dialogic teaching was designed specially. There is a lack of evidence on normal classroom talk and its positive effect on learning outcomes.

2.3.3 The necessity of considering the contribution of listening to learning

Although I agree that talk is an important approach to classroom participation and probably helpful in learning, there are some other modes of engagement, such as listening, which should not be ignored because they may also contribute to critical thinking and knowledge acquisition (Clark, 2015; O' Connor et al., 2017). Dialogue not only involves speakers, but also listeners, who are often overlooked in the analysis of dialogue (Schultz, 2009). Attentive listening has been seen as important as fluent use of words (see, e.g. Fisher, 2009). "What one person says acts as a catalyst for activating the thoughts of a listener" (Littleon & Mercer, 2013, p. 9), so when a person settles down to listen, he/she will take in useful ideas. According to Rotheram (1984), it usually requires a pause or silence for an individual to reflect on information before verbal communication occurs, as it is very hard to reflect on information deeply at the same time as talking. This is especially true when students are learning something entirely new, as keeping silent and listening may allow the assimilation of new information (Schultz, 2009).

Moreover, listening, by its nature, has some distinguishing characteristics as a supplement to talk: it has been suggested that there is value in "time for reflection, freedom from interruption, possibilities of holding ideas for long enough to see the links and forge new understanding" (Shultz, 2009, p. 40). Thus, keeping silent in order to listen arguably plays an essential role in classroom dialogue, and can also contribute to thinking, understanding and learning. The function of listening should not be ignored when emphasizing the importance of verbal contribution.

Empirical evidence endorsing the relevance of listening includes a study of sixth-form students in Cumbria, UK. Gibbons (1984) interviewed students who remained silent in classroom dialogue, and they reported that they had gained knowledge through listening to their peers' talk. This suggests that if a student listens carefully to others' talk, takes notes when necessary, learns diverse ideas, and thinks critically, he/she can also make good use of classroom dialogue. A more recent study conducted by Bosacki, Rose-Krasnor and Coplan (2014) found similar results. The researchers interviewed five Canadian elementary-school educators, and discussed their opinions about pupils' talking and listening behaviours. Results indicated that both talking and listening played a key role in classroom learning. Supporting interview scripts provide such examples as, "When it's listening time and, you know, one person speaks at a time…and we very much appreciate your ideas and the ideas of others…we listen to other people's ideas. And we learn from other people" (p.256).

It is noticeable that, in previous research, most results have come from theoretical argument or have employed qualitative evidence, while very few have provided quantitative evidence of learning gains resulting from listening in classroom dialogue. However, a very recent study, namely that conducted by O'Connor et al. (2017) provides strong quantitative evidence that silent students who are involved in classroom dialogue through listening are likely to achieve as good learning outcomes as those of talkative students. Forty-four students from grades 4 to 7 were involved, and the participants were from local schools in Massachusetts. Mathematics classroom dialogue was focused upon, as the subject was viewed as essential by the schools. Classroom talk was audio recorded and transcribed, and all individual words uttered were counted. Mathematics learning outcomes were assessed on the basis of the Stanford Diagnostic Mathematics Test score, a nationally normed standardized test required to be taken at the end of each school year. Multiple regression analyses showed that, after controlling for all other relevant factors (i.e. gender, classroom/teacher and lesson topic), the number of words spoken by a student could not be used to predict his/her test scores. O'Connor et al. concluded that there was no appreciable relationship between measures of a student's

verbal contribution to dialogue and measures of his/her learning outcomes; silent participants learned at the same level as students who engaged in talk. Based on the findings, the importance of listening actively was emphasized, which, according to O'Connor et al., needs to be seen as one form of participation in classroom dialogue. It was indicated that silent students should not be dismissed, as they may be following the discussion closely with interest, but not making verbal contributions. The reason that some students remained silent may be their need to manage time and clarify information. O'Connor et al. also suggest that, in whole-class settings, the belief that all students must talk actively is problematic. "There is less need to worry about including all students as vocal contributors (p. 12) and "students benefit from classroom dialogue, whether they are talking or not" (p. 10).

Asian students, including Chinese, are more silent in class compared to Western students, and many of them tend to participate in classroom dialogue through listening (Cheng et al., 2011; Clark & Gieve, 2006; Grimshaw, 2007; Kennedy, 2002). Given that my study's focus is Chinese students, considering silent participants in classroom dialogue and the contribution of listening to learning is particularly appropriate. There is evidence indicating that silent Asian students in classroom dialogue can secure as high a level of learning outcomes as vocal students do. One representative study was conducted in Japan by Inagaki, Hatano, and Morita (1998). Japanese students belong to Asian families and share similarities with Chinese students. Inagaki et al. selected 11 classes from grade 4 or 5, and 298 students were involved in total. Each class engaged in a whole-class dialogue lasting approximately 20 minutes, and the theme of their dialogue was strategies for solving the same mathematics problem. After the dialogue, the students were given a test to assess their learning outcome, which included the mathematics problem presented in class, and two similar ones. Inagaki et al. found that there was no significant difference between the silent and vocal students over performance on the test. They explained that socio-cultural norms in Asia might be more likely to ensure that students would be good listeners. Implications drawn included that active participation does not necessarily entail speaking out aloud, and student engagement, whether vocal or silent can serve as the driver of learning.

A more recent study conducted by Cheng et al. (2011) considered silent Chinese participants from the students' own perspectives. Three groups of students were selected for study, Chinese students in China (n=134), Chinese students in America (n=121), and American students (n=129). The students were asked to self-rate their learning behaviours. Cheng et al. found that Chinese students generally talked less frequently than Americans, and proportionally more Chinese students remained silent during classroom dialogue. Nevertheless,

little or no significant difference was found between the Chinese and American students in terms of their self-rated learning behaviours. “Chinese students did not consider themselves as being reluctant to be involved in the classroom activities or carry out independent thinking…Chinese learners might be quiet but independent thinkers” (p. 835). The silent Chinese reported that they had a satisfactory experience of learning and improved their understanding to the same extent as talkative students did.

To summarize, attentive listeners are certainly actively involved in learning, even though they cannot or will not talk a great deal in public. Students who prefer to learn in this way seem to be likely to secure academic achievements which are just as high as those of talkers. Thus, I suggest that both talking and listening are likely to contribute to learning, and I included both in my study.

2.4 The role of individual differences in the relationship between classroom dialogue and learning outcomes

Based on the review in Section 2.3, some students talk actively in classroom dialogue while others tend to remain silent and listen to others. Vocal students and silent students can both be seen as participants in classroom dialogue, and may be similarly likely to learn well. This leads to another question, namely, what kind of students prefer to talks and how do their verbal contributions facilitate their learning? What kinds of students tend to remain silent in classroom dialogue, and how does their listening foster their learning?

Talking and listening are helpful for learning, but may not facilitate the learning of all students equally well. Renzulli and Dai (2001, p. 26) have stated that different instructional and learning methods benefit students’ diversely, and “a one-size-fits-all instructional approach does not serve students equally well”. Talking and listening are two different approaches that a student can take to being involved in classroom dialogue. It seems to be inaccurate and arbitrary to state that more talking or listening in classroom dialogue will invariably lead to high achievement or otherwise. The relevance of participation in classroom dialogue may vary systematically with other variables. The key point is to examine under which conditions the relationship will vary, in other words, finding factors that influence the strength and direction of the relationship, that is identifying what is conventionally termed as a ‘moderator’. In O’Connor et al. (2017)’s study, referred to above, it was found that silent and vocal participation were both likely to facilitate learning. However, at the very end of the paper, the researchers state that the fact that some students engage in talk will not result in good learning outcomes for all students; similarly, silent participation is not a method that will enable

everyone to learn. O' Connor et al. suggest that students' individual characteristics should be considered in future studies to understand the kind of students who are suited to learning by talking or by listening. Including individual differences may help to explain the relationship between classroom dialogue and learning outcomes (Ellis, Goodyear, Prosser, & O' Hara, 2006; Schultz, 2009), with some students talking more to acquire knowledge, but others not necessarily viewing talk as a vehicle for learning (Fisher & Larkin, 2008; Pratt, 2006; Rop, 2003).

In a way, a social-cognitive theory proposed by Bandura (1986, 1989) supports this proposal. Socio-cognitive development is a complex and multidimensional process that involves aspects of both cognitive and affective reasoning, with the individual at the centre of a dynamic system of multi-social ecologies (Bandura, 2001; Bronfenbrenner, 2005; Bruner, 1996). Although acknowledging the critical importance of the environment, Bandura believes that individuals' own thoughts and mental activities are also essential and necessary for understanding how students learn and how well they learn. Despite the influence of environmental factors, students may intentionally choose a comfortable and preferable learning method, talk or listening based on their personal characteristics (O' Connor et al., 2017).

The usefulness of invoking individual characteristics is suggested by empirical studies, for instance, that of Ellis et al. (2006). They collected data from second-year undergraduate students. A combination of questionnaires and interviews was used to learn about students' performance in classroom discussion, and their perceptions of participation in talk. Course grades were collected to represent students' learning outcomes. Results indicated no significant association between participation in classroom talk and course grade, which was different from the researchers' expectations. Then the researchers interviewed some of the students in order to attempt to understand this phenomenon. Interview transcripts showed that the students had a clear idea of what was appropriate for their learning, and then purposely chose whether or not to talk in classroom discussion. Moreover, the researchers also noted that the students' perceptions about classroom talk varied greatly from person to person. Some students indicated that discussion provided good opportunities to learn, for instance, "*I do enjoy being there and having that instantaneous kind of being able to converse and everything…I mean it gives you a chance to kind of reflect on what you think and everything, like your own thoughts*" (p. 251). Others preferred to listen to their classmates talking, or did not think talk was of much value to their learning, for instance, "*I don't think there is that much learning, I think it's just embracing different ideas and I don't think you are actually learning something*" (p. 251). Despite the diverse attitudes towards silence and talk, students were likely to achieve similarly high scores

in tests. As seen from the interviews, whether participation in classroom dialogue contributes to learning, and how contributions are made may depend on further individual characteristics.

2.5 Thinking style as a proposed moderator of the dialogue and learning relationship

2.5.1 Individual characteristics in relation to classroom dialogue

Connected to the above, the next step is to find an individual characteristic that is reasonable and convincing in terms of explaining participation in classroom dialogue and its effects on learning. Previously, very few studies have linked individual characteristics, participation in classroom dialogue and learning outcome together. For instance, individual characteristics are rarely included when examining the effect of participation in classroom dialogue on learning outcomes. Also, there is little research considering learning outcomes when investigating the relationship between individual characteristics and classroom dialogue, as has been pointed out in Howe and Abedin (2013). Nevertheless, there is abundant evidence of the relationship between individual characteristics and classroom dialogue. Many individual characteristics have been used to explain students' diverse participation behaviours in classroom dialogue (see Howe & Abedin, 2013). According to the socio-cognitive theory, students tend to choose a comfortable and preferable learning method, namely talking or listening in classroom dialogue, based on personal characteristics. Learning outcomes are found to be better if students are allowed to learn using a comfortable learning method (Dallimore et al., 2010). It may be possible to see implications for learning outcomes based on the existing evidence concerning the relationship between individual characteristics and classroom dialogue. According to Howe and Abedin (2013), out of the many different individual characteristics related to students' participation, gender, ethnicity and academic achievement are three of factors that have been the most heavily studied during the past 40 years. Comparably, research on other individual characteristics is so rare that Howe and Abedin (2013) have advised against drawing conclusions from its findings. Therefore, this study systematically reviews and assesses the literature in relation to how gender, ethnicity and academic achievement explain participation in dialogue. From this it may be possible to infer a reasonable individual characteristic that moderates the relationship between participation and learning outcomes.

2.5.1.1 Gender and its relationship with participation

As reviewed by Howe (1997) and Howe and Abedin (2013), gender is a predominant factor that is related to classroom dialogue, yet results vary across different studies. Some studies

provide evidence that boys contribute more and better talk than girls (see Howe & Abedin, 2013). In terms of frequency of talk, boys tend to raise hands to answer questions (Julé, 2005; Younger, Warrington, & Williams, 1999) and call out answers spontaneously (Duffy, Warren, & Walsh, 2001; Smith, Hardman, & Higgins, 2007). Moreover, boys are more likely to initiate dialogue than girls, for example, by asking more questions or starting more topics (She, 2000; Smith et al., 2007). As regards the quality of talk, boys' superiority has also been apparent (Howe, 1997), which is especially demonstrated through their level of reasoning (Swann & Graddol, 1988). For instance, on the basis of data collected from primary school students, Swann and Graddol (1988) found that girls' contributions were substantially briefer than those made by boys, which was reflected in 'total words spoken' (girls = 154, boys = 489) and 'total interchanges made' (girls = 24, boys= 84). They also reported that boys added detailed explanations to supplement their answers, while girls were prone solely to stating facts. This made boys' views more acceptable by peers and they often led the direction of a dialogue.

However, not all scholars have accepted these gender differences and fewer gender differences in relation to classroom participation have been reported during recent years (see Howe & Abedin, 2013). For instance, a study conducted by Burns and Myhill (2004) in three primary schools produced rather controversial results in the light of previous research. Their study involved 54 lessons covering literacy, numeracy and other sessions. In order to ensure the reliability of their results, they used quantitative methods as well as qualitative ones, which were rigorous and convincing. Yet they found that girls participated more often in classroom dialogue than boys, for instance, putting hands up more frequently, joining in more collective responses, or being invited to answer more questions. Similarly, the high quality of contributions were also disproportionately produced by girls, while boys were more likely to receive negative feedback or a reprimand from teachers. A study reported in Duffy et al. (2001) focused on high school students, where a total of 597 students (294 female students and 303 male students) were observed in either 18 mathematics classes or 18 literature classes. Duffy et al. found that there was no gender difference among students in the frequency of responding to questions asked by teachers. Similarly, a study (Canada & Pringle, 1995) conducted with college students also found that females and males did not differ significantly in relation to interactions with teachers, including raising questions or contributing answers in response to teachers' initiations.

Another challenge with regard to the use of gender to explain participation is that findings are not consistent among all members within one gender. This has been found in studies conducted by Jones and Gerig (1994), for instance. These authors collected data relating to 101

secondary school students in California and results turned out to be no significant participation difference between boys and girls ($\chi^2 = 0.35$, *ns*). Their results revealed that the dominant role in dialogue stemmed from the talkativeness of a subgroup boys, while the remaining boys tended to keep silent. It is noticed that, even in studies reporting significant gender variation in terms of participation, some still admit that the difference only characterizes a group of boys or girls, while the remaining students tend to show similar participation in classroom dialogue (see e.g. French & French, 1984; Swann & Graddol, 1988). "There is variability within each group - there are some talkative girls and quiet boys." (Swann & Graddol, 1988, p. 52). To sum up, the contrasting results produced by different studies and the inconsistent behaviours within each gender suggest that gender is a far from adequate factor when it comes to explaining students' participation in classroom dialogue.

2.5.1.2 Ethnicity and its relationship with participation

Studies on the relationship between ethnicity and classroom participation show a similar trend to that of gender, with conflicting results being reported. Some scholars state that ethnicity can be used in determining the extent of classroom participation, and it is Western students who usually play a more active role than students from minority ethnic groups (Biggs & Edwards, 1991; Conwell, Griffin, & Algozzine, 1993; Dunkin & Doenau, 1982; Shachar & Sharan, 1994). One representative study has been conducted by Shachar and Sharan (1994) using data from grade eight students in Israel. They found that Western students talked significantly more often ($F = 5.75$, $p < .05$) and used more words ($F = 4.16$, $p < .01$) in whole-class interaction than Israeli students, including when clarification was required or given, and when stating agreement. Moreover, Shachar and Sharan reported that Western students contributed higher-level dialogue and used more strategies than Israeli students ($F= 13.09$, $p < .05$), especially with respect to 'repetition with expansion', 'explanation with evidence' and 'suggesting an idea'.

Yet some other studies have argued that there is no obvious difference in participation across ethnic groups (e.g. Jones & Gerig, 1994; Nystrand et al., 2003). For instance, Nystrand et al. (2003) collected data from more than 200 8th and 9th grade classes. The finding was that there was no significant difference between African American and white students in classroom participation, as was revealed by the extent to which they asked and answered questions and provided evaluations. Similar results were also identified by Jones and Gerig (1994) based on data covering white, black and other ethnic groups, indicating dialogue contributed by students from these ethnicities was not significantly different. Students from minority groups are not

necessarily silent in classroom discussion, instead some are as likely to participate as majority ones or do so even more actively (Tennant, 2004). Conducting observations in 10 secondary schools located in London, Tennant (2004) collected data from a wide range of ethnic groups: white, African-Caribbean, Asian, and some other groups. He found that African-Caribbean students, a traditional minority ethnic group in London, interacted significantly more than the average with teachers and peers, and to almost the same extent as white pupils. These findings indicate that it is not reliable to state that students from minority ethnic groups talk less than those from majority groups. Indeed, the results from this body of work as a whole imply that there is no strong relationship between ethnicity and participation in classroom dialogue, and attempting to predict students' participation from their ethnic backgrounds is unlikely to prove productive.

2.5.1.3 Academic achievement and its relationship with participation

Because of the controversial results reported by different studies and the inconsistent performances within one group, gender and ethnicity can play only a limited role in explaining students' participation in classroom dialogue. In order to better explain varying participation, many scholars have examined demographic factors in conjunction with academic achievement (Howe & Abedin, 2013). Noticeably, the academic achievement examined in these studies more often refers to the examination scores students attained before they participated in classroom dialogue. Academic achievement is found to be a more convincing factor than gender or ethnicity, and there is a strong sense of positive relationship with participation in classroom dialogue (Burns & Myhill, 2004; Good, Sikes, & Brophy, 1973; Nystrand et al., 2003).

High achievers' focal role in participation frequency is illustrated in studies, such as that of Burns and Myhill (2004). They divided the primary school participants into four groups: high achievers and low achievers, and boys and girls. It was found that academic achievement was more strongly associated with participation frequency than gender, especially in relation to 'putting hands up' (boy/girl= 1: 1.3, low achiever/ high achiever= 1: 1.8) and 'joining in collective answering' (boy/girl= 1: 1.1; low achiever/ high achiever= 1: 1.7). Apart from frequency, high-quality participation is more likely to be observed with high-achieving students (Good et al., 1973; Nystrand et al., 2003; Nystrand & Gamoran, 1991). Good et al. (1973) found that high achievers performed considerably better in answering open questions, which demanded capability for information organization and evaluation. The same situation was also identified by Nystrand et al. (2003) based on data collected from more than 200 8th

and 9th grade classes covering English and social science subjects. They reported that dialogue containing comments, initiations and evaluations at a higher cognitive level was more likely to be contributed by students from high-achieving classes than those from low-achieving classes.

One commonly used reason for explaining the above phenomenon is that academic achievement reflects the capability of a student to solve problems and master learning contents (Renzulli & Dai, 2001). Based on this view, students who attain high scores should be more successful at figuring out answers to teachers' questions. Thus, these students should be more likely to respond to teachers and share their opinions in whole-class interaction. In comparison, silent students are usually regarded as less capable. The explanation is that because they do "not know how to respond to teachers' questions", they are not willing to participate in classroom dialogue (see Schultz, 2009, p. 20). Capability therefore is typically used to interpret the positive correlation between academic achievement and classroom participation (see Good et al., 1973).

However, more and more scholars have disputed that whether high-achieving students invariably contribute more in classroom dialogue (e.g. Jones & Gerig, 1994; Kosko, 2012; Myhill, 2002; Tennant, 2004). For instance, Jones and Gerig (1994) ranked students into four achievement levels according to a test taken beforehand. It turned out that there was no significant difference in the proportion of silent students and active participants across the four levels ($\chi^2 = 6.23$, *ns*). This suggests that active participants are not necessarily high-achieving students. A similar message was flagged by Kosko (2012), who conducted a longitudinal study on students' participation in mathematics discussions using a database (NCES, 2009) containing information collected by the US government. The data were collected from kindergarten through to grade eight, with a sample of 2,832 participants in grade eight. Kosko's findings indicated that there was no significantly positive relationship between academic achievement and participation in class discussions. In particular, high achievers in the later grades participated very infrequently. Academic achievement seems to be unable to explain why some high-achieving students do not participate actively in dialogue, while a few low achievers talk a lot. Although high-achieving students may be more capable of contributing productively, some of them may not prefer to do so. This suggests that investigations into participation behaviours and the corresponding learning results should allow for students' preferences.

The above review shows that most studies concerning the relationships between individual characteristics and classroom talk focus on primary and secondary school students.

It might be interesting to see how the relationships work with older students, for example, those in high schools. More importantly, popular though gender, ethnicity and achievement may be in research, the varied performances within one group and disregard of students' preferences suggest that these three factors are insufficient to account for the observed variation. Arguably, a variable that embodies students' preferences in thinking and learning is an appropriate next step in the search for adequate explanations of students' diverse participation behaviours, which may correspondingly affect the learning outcomes attained from particular forms of participation.

2.5.2 The rationality of considering thinking style

Style may be an appropriate candidate for bridging the current gap, as it is a term used to describe individuals' preferred ways of managing behaviour and processing information (Coffield, Moseley, Hall, & Ecclestone, 2004; Kozhevnikov, Evan, & Kosslyn, 2014; Sternberg, 1997; Waring & Evans, 2015; Zhang, 2013). As an essential aspect of individual differences, styles have been applied frequently in education, and their influence on students' learning process and outcomes have been increasingly emphasized (Evans, 2015; Kozhevnikov et al, 2014; Zhang, Sternberg, Rayner, 2012).

Students vary enormously in the style or manner in which they pick up and process information (Allinson & Hayes, 1988; Biggs, 2001). "An individual's preferred and habitual approach to organising and representing information" is different (Riding & Rayner, 1998, p. 7-8). For instance, some people tend to process information quickly, while others will take more time (Pederson, Plomin, & McClearn, 1994); some people prefer to process information in cooperation with peers, while others like to think alone (Sternberg, 1997); some people show "immediate judgment based on feeling, and an adoption of a global perspective", while others tend to evaluate and compare information, and focus more on details (Allinson & Hayes, 1988, p. 122). Notably, people often confuse styles with personality, and some may even claim that there is less need to study styles given that an overall concept, namely, personality, already exists (see Zhang, 2006). However, it has been found that while styles and personality overlap a little, the correlation is small, indicating that they are different concepts (Vermunt & Vermetten, 2004; Zhang, 2002a, 2002b, 2006). Moreover, although personality and styles are both terms used to describe individuals' habitual ways of doing things, personality is an overall concept relating to the managment of people's behaviours (Deweck, 1996), while styles focus more on ways of processing information and brain activity (Coffield et al., 2004; Sternberg, 1997). This latter may be more suitable for explaining students' learning processes and

outcomes. Thus I decided to focus on styles in my research and to test their role in explaining how students benefit from classroom participation.

The influence of style on the relationship between participation in classroom dialogue and learning outcomes has rarely been discussed in the literature or explored through empirical studies (Cheng et al., 2011). However, scholars tend to agree that style plays an essential role in affecting students' learning processes (Riding, 1997; Riding & Sadler-Smith, 1999; Zhang, 2006). It is assumed by Sternberg (1997) that different students characteristically show different thinking styles, and accordingly they approach learning tasks differently, with some preferring to talk and others tending to be quiet in class. We can probably infer that when a student is allowed to participate in classroom dialogue using their preferred ways, he/she will have a comfortable and high level of learning experience, which may lead to a desirable learning outcome.

There are a few empirical studies suggesting that style may affect how students benefit from participation in classroom dialogue, for instance, the one conducted by Jones and Gerig (1994). When they failed to demonstrate the expected positive relationship between talk and academic achievement, they tried to work out how to explain their results. To this end, they interviewed silent students about how they felt about participation and why they did not talk in class. They found that 67 per cent of silent students preferred to work alone, rather than use spoken language, for the purpose of effective learning (e.g. 'I like to listen to the teacher,' 'I pay attention to my work more than I talk'). Preference for thinking and working alone is a sign of thinking style. Also, when asked about whether remaining silent prevented them from learning, many of the students (41%) indicated that they had mastered the learning content and could learn well (e.g. 'I know the answers, just uncomfortable to talk in front of my classmates'). Jones and Gerig's study gives an indication that, for a certain style of thinking, remaining silent in classroom dialogue may be helpful in ensuring a satisfactory learning outcome.

A more recent study by Cheng et al. (2011) probably provides stronger evidence for the moderating role of style. Cheng et al. used the Style of Learning and Thinking Questionnaire (SOLAT) designed by Torrance (1988) to measure thinking styles, and the questionnaire divided students' thinking into holistic and analytic. Analytic is defined by Alesandrini, Wittirock and Langstaff (1984, p. 152) as that which "enables an individual to reduce information such as a stimulus array to its essential component parts – that is, to extract what is relevant from potentially distracting surroundings". The analytical style is characterized by its ability to facilitate the learner's use of deep-processing strategies in critically classifying

information. Holistic styles by contrast enable individuals to relate new information to prior knowledge, and integrate discrete information into a meaningful whole. Cheng et al. asked students to self-report their learning behaviours, which included appearance of talk, raising questions, indication of understanding and independent thinking. They found that American students were more likely to be characterized by their use of analytical styles, while Chinese students tended to have a high tendency to holistic styles. Compared with Americans, Chinese students rated themselves relatively lower in terms of usage of talk and raising questions. However, as regards indications of understanding and independent thinking, the ratings between Chinese and Americans showed no significant differences. Cheng et al. concluded that the differences in performance in classroom dialogue between the American and Chinese students could be attributed to their styles. Although the study did not assess academic achievement directly, it is implied from the findings that, for students characterized with different kinds of styles, talking or listening in classroom dialogue exert different influences on learning outcomes. Both talk and listening can be used to increase understanding and thinking, depending on the different styles with which students are characterized. As implied by the arguments put forward in the literature and empirical studies, it is rational to use style to investigate the relationship between participation in classroom dialogue and learning outcomes.

2.5.3 My positionality on styles

The field of style has lacked a clear identity for a long time as people have not reached a consensus over the many style constructs and the nature of styles. There are debates about five major aspects, which are illustrated as follows, together with a justification of my positionality on styles.

2.5.3.1 Conceptualization of styles

Different scholars have proposed a variety of style constructs and correspondingly many different terms have been introduced to refer to the concept of style, such as ‘cognitive style’, ‘learning style’, ‘decision-making style’, thinking style’, ‘learning pattern’, ‘approaches to learning’, ‘dispositions to learning’ and so on (Kozhevnikov et al., 2014; Zhang, 2013). Reviews of literature on styles indicate that the number of style labels has increased a great deal since the nineteenth century and continues to multiply (Evans & Waring, 2012; Zhang, 2013). Hayes and Allinson (1994) identified 22 dimensions of cognitive styles, and five years later, Armstrong recognized 54 style dimensions. A more recent review conducted by Coffield

et al. (2004) pinpointed 71 style dimensions. When new styles are proposed, they usually lack clear definitions and fail to show how they differ from traditional styles (Kozhevnikov et al., 2014). This diversity of conceptualization led to more chaos in the style field.

There have been various attempts to sort out many of the conceptualizations. Grigorenko and Sternberg (1997) differentiated the cognitive and personality styles from those involved in the activity approach (e.g. learning or teaching style). They believed that cognitive and personality styles are consistent across various tasks and situations, and remain stable over time, which means they can be modified very little, if at all, by training during the life-span. In contrast, learning and teaching styles are more dynamic and depend on changes in the educational environment. In order to encompass the above approaches, Sternberg (1997) proposed a term 'thinking style' to act as a buffer between internal characteristics and environmental elements. Peterson, Rayner, and Armstrong (2009, p. 11) distinguished between cognitive style and learning style: Cognitive styles are viewed as "individual differences in processing that are integrally linked to a person's cognitive system…they are a person's preferred way of processing…they are partly fixed, relatively stable and possibly innate preferences"; learning styles represent "an individual's preferred way of responding (cognitively and behaviorally) to learning tasks which change depending on the environment or context".

Instead of making distinctions under the label of style, there are a number of scholars who have begun to use different terminologies, such as 'pattern', to clarify their stands on individual learning differences. For example, Vermunt gave up the use of 'learning styles' and then employed 'learning patterns'. According to Evans and Vermunt (2013, p. 185), style constructs stress "person-bound differences in the way individuals go about learning"; 'approaches' emphasizes the influence of environmental and contextual elements on the way students learn; the 'pattern' construct assumes that "the way students learn is influenced both by personal and contextual determinants".

Apart from distinguishing between many of the style constructs, there are attempts that seek to build a common language in the style field. Zhang and Sternberg (2005) invented a term 'intellectual style' as an umbrella concept that can encompass and represent all style constructs, with or without the root word 'style'. Alternatively, 'personality learning style' is a term employed by Evans and Waring (2009) and Rayner (2000) as an overall concept to integrate style constructs. The concept proposed by Kozhevnikov et al. (2014) is probably more representative of the current trend and is a conceptualization I hold. Having considered various

approaches, Kozhevnikov et al. characterized style as "patterns of adaptation to the external world that develop on the basis of innate predispositions, the interactions among which are shaped by changing environmental demands" (p. 3).

To summarize, despite various attempts, people have not reached a consensus over terminology and conceptualization of styles (Zhang, 2013). The choice and usage of style in education depends crucially on the particular need of a given research study, and on how the nature of style is perceived: fixed or mobile, dimensionality, pejorative or non-pejorative (Evans & Waring, 2012).

2.5.3.2 Debates on the malleability of styles

One long-standing controversial issue in the field of style is style malleability, in other words, people debate whether or not styles are variable over time (Evans & Vermunt, 2013; Zhang, 2013). There is one group of scholars who hold the view that styles are stable and tend to remain unchanged, especially after the formative years. Styles, in their mind, are conceived essentially not sensitive to context, being static "in-built features of the individual" (Riding & Cheema, 1991, p. 196). Biological and genetic elements are normally emphasized and viewed as playing a dominant role in determining people's styles (Messick, 1996; Royce, 1973). In comparison, the other group believes that styles are amenable to change according to the variation in the environment (Zhang, 2013). The development of styles is a product of socialization, during which process families, schools, careers and sociocultural contexts gradually influence how people tend to think and behave (Kozhevnikov et al., 2014; Sternberg, 1997). Styles can also be taught and individuals can be purposely trained in order to meet the requirement for personal development (Evans & Waring, 2012; Zhang, 2013).

My personal view on the issue of style malleability inclines towards the second group, namely, that styles are relatively stable but are amenable to change over time in response to the changes in physical and sociocultural environments. Individuals' styles are influenced not only by genetic and biological factors, but are also shaped by contextual and environment factors. There are both elements of stability and variability in styles. I hold the above view for two main reasons. The first reason is a recognition of the need for personal development in educational practice. If styles are treated as fixed traits, any attempts to train and cultivate style would be pointless (Zhang, 2013). In comparison, if people agree that styles are dynamic and relatively modifiable, their development of styles would result in an increase in students' capacity to adapt to environments (Kozhevnikov et al., 2014). Thus, more scholars and practical educators would be willing to invest efforts in research into style (Zhang, 2013).

The second and more important reason is the findings of cross-sectional studies, especially more recent ones (e.g. Kozhevnikov et al., 2014; Evans & Vermunt, 2013; Zhang, 2013). A number of studies show that the development of styles is associated with both genes and environments. For example, the Witkins' (1959) style construct, namely, field independence-field dependence (FDI) has been examined by a great many studies and has given rise to much discussion. There is evidence that a high level of field independence in an individual is determined by a recessive gene on the X-chromosome (Bock & Kolakowski, 1973; Wertheimer, 1945). At the same time, other scholars have proved the modifiability of FDI, as they have found that socialization factors (e.g., age, sex-role patterns, child-rearing practices) influence the development of styles beyond the impact of genes (Connor, Schackman, & Serbin, 1978; Renner, 1970). More recently, after reviewing style research in psychology and neuroscience, Kozhevnikov et al. (2014) have characterized cognitive style as involving environmentally sensitive individual differences in cognition. According to their view, individuals develop a particular pattern of styles in order to adapt to the environment; with changes in the environment (e.g. family, education, career), their styles continue to be shaped over time based on innate predispositions. An individual and his/her environments interact consistently causing style to have the characteristics of both stability and variability.

The book published by Zhang (2013) on style malleability provides strong evidence to show styles are more dynamic rather than fixed. The findings demonstrated in Chapter II of her book indicate that styles vary and are malleable as a function of gender, culture, academic discipline and occupation. Moreover, the findings obtained from longitudinal studies have proved convincingly that styles are dynamic and can change over time (see Zhang, 2013, Chapter III). It is noticeable that my agreement regarding the malleability of styles does not mean that they change constantly or day by day, otherwise, the study of individuals' styles would be meaningless. Instead, "changes in style more often take the form of a slow process. Styles may simultaneously change and become stable, then change again under necessary conditions" (Zhang, 2013, p. 288). Individuals' styles are likely to remain stable when their environments are relatively constant (Cools & Bellens, 2012; Vanthournout, Donche, Gijbels, & Van Petegem, 2011) and within a certain period of time, for example, six months (Bouckenooghe, Cools, Clercq, Vanderheyden, & Fatima, 2016). On the basis of the above empirical evidence, I considered styles to be relatively stable but subject to change over time with respect to variation of environment.

2.5.3.3 Debates on the dimensionality of styles

Scholars hold controversial points of view on the dimensionality of styles, which include two issues: bipolar-unipolar and unidimensional-multidimensional. Regarding the bipolar-unipolar issue, I personally believe that styles are unipolar, which means only one end (pole) is named with a construct. An individual is likely to show the characteristics of a pair of styles. Scholars such as Sternberg (1997) and Zhang (2013) hold the same view. People are characterized with respect to each style to differing degrees (Sternberg, 1997) and "styles are perceived as falling along continua rather than as being dichotomous" (Zhang, 2001, p. 623). In comparison, a number of style constructs are proposed as bipolar. In these constructs, a pair of styles with opposite meanings are identified and an individual who has a high tendency to favouring one polar type of style will show a low tendency towards the opposite type. For example, Witkin (1959) labels people as either field-independent or field-dependent, which is somewhat polarized and overlooks the complexity of each person's mental world (Biggs, 2001; Sternberg, 1997). A dichotomous construct of style seems to be biased towards assessing individuals' preference in terms of thinking and processing information.

Regarding the issue of whether styles are uni-dimensional or multi-dimensional, some people believe that people can be characterized with only one of styles. For example, Honey and Mumford (2000) have designed four styles: activists, reflectors, theorists and pragmatists; Jackson (2002) also divides people into four styles: initiator, reasoner, analyst and implementer. The styles are mutually exclusive; in other words, people can be labelled with only one of the styles. This is a quite limited description of styles. Some people indicate that people can be characterized with multiple styles. For instance, Sternberg proposes 13 thinking styles along five dimensions. Within each dimension, individuals are characterized by a preference for at least one style, and thus many combinations of style are possible. I hold the view that styles are multidimensional. Each individual is characterized with a range of thinking styles simultaneously, rather than merely one. For instance, students may like to work collaboratively with peers, which is high on the external dimension; at the same time, they may like to discover the unknown and thus may fit the liberal style. As a result, they will have characteristics of both external and liberal styles. This is an advantageous way of demonstrating a multifaceted and overall account of an individual's styles.

2.5.3.4. Debates on the value of styles

Scholars debating this issue are attempting to answer to the question of whether some styles are better than others or whether they are equal in value? This is a thorny issue which it is

difficult for people to reach a consensus (Zhang, 2013). Some people hold the view that styles are value-laden, in other words, styles can be assessed as better or worse. (e.g. Entwistle, 1998; Jackson, 2002; Kogan, 1989). For instance, there is a hierarchy within the styles proposed by Vermunt (Busato, Prins, Elshout, & Hamaker, 2000) and they seem to share the attributes of ability (Renzulli & Dai, 2001). Busato, Prins, Hamaker and Visser (1995) found that the styles proposed by Vermunt were significantly correlated with abilities. Students characterized with the meaning-directed learning style were found to have a higher cognitive ability; by contrast, the undirected style, described as finding study difficult, lacking confidence and feeling insecure, had a significantly negative relationship with ability. People characterized with the undirected style are almost never comparable to those characterized with meaning-directed style no matter which context they are in.

In comparison, another group of people consider that styles are value-free (e.g. Messick, 1996; Sternberg, 1997). Style is a matter of how people deal with tasks not how well they accomplish them. For example, according to Sternberg (1996, p. 347), a style is "a preference for using abilities in certain ways. It is not an ability itself, but rather a way in which one likes to utilize abilities…when we speak of individual differences in thinking styles, we are referring only to differences, not to 'better' or 'worse'". To continue, Zhang and Sternberg (2005) have classified styles into three groups, Type I, Type II and Type III styles. Studies show that Type I styles share the attributes of cognitive complexity, non-conformity and low degrees of structure; while Type II styles normally feature cognitive simplicity, conformity, authority, and high degrees of structure. However, when examining the relationship between styles and learning, Type II styles more often predict higher academic achievement than Type I styles (Zhang, 2013). Sternberg and Zhang have not reached a conclusion with regard to this issue. I personally think that the styles proposed by Sternberg are value-free, because no one style is better than another in an absolute sense. Whether a style works well depends on the requirements of certain tasks and contexts. For example, Type I styles may work better when people start up a new company, but are not as important as Type II when people work in a government department that requires conformity. Different style constructs vary with respect to the issue of style value. My view on the issue of style value is subjective to change depending on future empirical evidence.

2.5.3.5 Debates on the matching hypothesis

Many debates have taken place over the pejorative nature of style, which is reflected in the relationship between style matching and performance (Evans, 2013; Evans & Vermunt, 2013).

The matching hypothesis used to be quite popular. Its traditional narrow interpretation is that students will learn better if a teaching method matches their preferred styles (see Hayes & Allinson, 1996, for a review). A broader interpretation proposed by Pashler, McDaniel, Rowher and Bjork (2009) is that the matching hypothesis concerns not only direct matching (see above), but also mismatching of styles, which means that students sometimes are likely to learn well when a teaching method does not match their styles. As Evans and Vermunt (2013, p.187) expressed it, "matching or meshing could involve those with one style doing better with a prescribed treatment that was or was not aligned with their own style".

However, the matching hypothesis is not recognized by all people and more scholars, including myself, have started to develop a sceptical view of it recently. The first reason is due to controversial results reported in different studies. Hudak (1985) implies that a match between thinking styles and learning methods is viewed as offering greater opportunities for intellectual development, realizing students' potential and achieving desired learning outcomes. Biggs (2001, p. 79) also agrees with this proposal, stating that "individuals with a particular style can achieve well if the task allows them to use their dominant style". However, another group of scholars have indicated that sometimes a mismatch between styles and teaching instructions can bring about more effective learning achievement (e.g. Nicholls, 2002) and potential long-time benefits (e.g. Kolb, 1984). Other scholars have indicated that lack of empirical evidence can be used to prove whether there is any influence on learning when students' preferred styles are mateched with a teaching method (Pashler, McDaniel, Rowher, & Bjork, 2009; Scott, 2010). Secondly, people have queried the practical value of the matching hypothsis (Kozhevnikov et al., 2014). What does it mean to adapt teaching methods to learning style? This matching proposal is likely to capitalize on students' stronger or preferred styles while leaving their less preferred styles in a disadvantaged state. In comparsion, a temporary mismatch between students' styles and teaching methods may foster the development of their least preferred styles and take advantage of the activities that they would not use of their own accord (Evans & Vermunt, 2013; Vermunt & Verloop, 1999). This may potentially be helpful for students' personal development (Evans & Vermunt, 2013). Thirdly, in education practice, it is unrealistic to tailor various instructions in order to match each student's preferred styles. As indicated before, I hold the view that styles are multidimentional and malleable, and thus it would be difficult and less valuable to tailor a teaching method that is compatible with an individual's multiple styles (Evans & Cools, 2011; Evans & Waring, 2012). This is especially true in the context of mainland China, where 50 or more students share one lesson. It is unfeasible to adapt teaching methods to each individual's characterized styles.

Given the limitations of the matching hypothesis, a number of scholars have embraced the idea of style flexibility. Style flexibility refers to how people can flexibly switch between styles and choose the most appropriate in a given situation (Alferink, & Farmer-Dougan, 2010; Barnett, 2011). Styles vary in terms of the level of flexibility, with some students being capable of greater flexibility than others, depending on the demands of tasks (Evans & Vermunt, 2013; Zhang, 2013). A key question here is whether style flexibility is a meta-style (Kozhevnikov, 2007) or represents the addition of other individual learning differences (see Evans & Vermunt, 2013)? More empirical evidence is needed here and caution should be used when trying to teach all students style flexibility (Curry, 1990; Evans & Waring, 2012).

The importance of self-regulation is emphasized, this referring to learners‘ capacity to discern the most appropriate way of working and teaching in relation to the demands of a specific task (Evans & Vermunt, 2013). The broad definition of self-regulation includes aspects of metacognitive knowledge and regulation of learning (Dinsmore, Alexander, & Loughlin, 2008; Endedijk, Vermunt, Meijer & Brekelmans, 2014; Vermunt & Endedijk, 2011; Vermunt & Vermetten, 2004). According to Vermunt and Endedjik (2011), the metacognitive knowledge part refers to an understanding or knowledge that students have about their learning. This part includes conceptions of learning, and preferences for certain learning and regulation strategies. The regulation of learning is defined as learners' proactive behavior to reach their learning goals and responds to the demands of the learning task (Pintrich, 2004). Students' capacity to self-regulate their learning vary, and in particular, they prefer to employ different regulation strategies. For instance, some students rely mostly on themselves to regulate their learning, while some others are unable to self-regulate their learning process and need to seek external help (Vermunt & Vermetten, 2004). Also, personal factors (e.g. personality, personal experiences in teaching and learning, gender) and contextual factors (e.g. social environment, school climates, teaching methods) are likely to influence self-regulation (Vermunt & Endedijk, 2011). Our capacity to self-regulate may vary across tasks and contexts. A high level of self-regulation is likely to facilitate students' learning achievements (Evans & Vermunt, 2013; Vermunt & Endedijk, 2011). Students should be supported to develop their capacity to know the most appropriate strategies for learning in relation to the demands of a specific task.

My personal view is that the matching hypothesis is quite narrow and limited with regard to instructing people in how to apply style research to make use of teaching methods and improve learning. Although it is premature to show my position on the issue of style flexibility, I highlight the importance of self-regulation and the fact that "students need to be supported to

develop strategies to maximize what they can access from different ways of teaching" (Evans & Vermunt, 2013, p. 192). Even though someone's preferred styles are less flexible, he/she should be supported to develop strategies to adapt to teaching instructions (Evans & Waring, 2012).

To summarize, my positionality over the controversial issues of styles is as follows: styles are relatively stable but can be changed over time as an adaptation to environments; styles are unipolar and multidimentional; styles are viewed as equal in value, but my view is subject to change depending on whether more empricial evidence is produced; the matching hypothesis is quite limited in its instruction to people to translate style research into educational practice. Students should develop self-regulation, and choose appropriate strategies or styles to maximize their use of the learning environment; in order to do this they need to be exposed to other ways of being and doing.

2.5.4 Choosing Sternberg's style construct for my study

I decided to employ the style construct developed by Sternberg, which I will firstly introduce and then justify the reasons for this choice. It was selected because Sternberg's style construct is arguably the most suitable for my study, which does not mean it is necessarily better in an absolute sense.

2.5.4.1 An introduction of Sternberg's style construct

Sternberg (1997) developed a theory called Mental Self-Government to demonstrate his view on thinking styles. The metaphor of 'government' is used, suggesting that the function of thinking styles for individuals is like the function of government for society, which is managing how people behave. Sternberg (1997) defined thinking styles as individuals' preferred ways of processing information and views them as an essential aspect of individual differences (Zhang, Sternberg, & Fan, 2013). In Sternberg's model, 13 thinking styles are categorized according to five dimensions - function, form, level, scope and leaning, which as inspired by the management of government systems. Descriptions of each style are summarized in Table 2.1.

Table 2.1 Thinking styles in the Theory of Mental Self-Government

Dimension	Thinking style	Key characteristics
Function	Legislative	Work on tasks that require creative strategies; choose one's own activities

	Executive	Work on tasks with clear instructions and structures; implement tasks with established guidelines.
	Judicial	Work on tasks that allow for one's evaluation; evaluate and judge the performance of other people.
Form	Hierarchical	Distribute attention to several tasks that are prioritized according to one's valuing of the tasks.
	Monarchic	Work on tasks that allow complete focus on one thing at a time.
	Oligarchic	Work on multiple tasks in the service of multiple objectives, without setting priorities.
	Anarchic	Work on tasks that allow flexibility as to what, where, when, and how one works.
Level	Global	Pay more attention to the overall picture of an issue and to abstract ideas.
	Local	Work on tasks that require working with concrete details.
Scope	Internal	Work on tasks that allow one to work as an independent unit.
	External	Work on tasks that allow collaborative ventures with other people.
Leaning	Liberal	Work on tasks that involve novelty and ambiguity.
	Conservative	Work on tasks that allow one to adhere to the existing rules and procedures in performing tasks.

(Zhang & Sternberg, 2005, p. 12, Table II)

Function dimension: Just as branches in government systems serve a variety of functions, individuals also have different thinking styles for focusing on different functions or tasks. Legislative, executive and judicial styles are identified in terms of the function dimension. People who are characterized with a legislative style prefer to work or study in their own way, and decide for themselves what to do and how to do things. In contrast, people who are relatively executive tend to implement tasks within guidelines and regulations, and work according to pre-existing rules. They prefer to follow teachers' orders and memorize content, instead of pioneering new methods. People characterized by a preference for the judicial style like to compare and evaluate work processes and objectives. They are critical of people and their activities, and they view justice as a top priority.

Level dimension: Governments operate at different levels: national, provincial, regional and so on. Similarly, in the case of people's mental self-government, individuals may vary in terms of their concern about detail. Global and local styles are classified according to level. People characterized with a global style prefer to deal with tasks that are general and abstract. This kind of person tends to make plans before they start to work on a task. Conversely, people featured with a local style prefer to work on tasks that require them to attend to concrete and specific details.

Leaning dimension: In governance, political orientations range from the most conservative to the most liberal. These two major leanings, conservative and liberal, can also be identified in mental self-government. People characterized with a liberal style prefer to go beyond existing rules and gain access to new things. They are likely to come up with creative ideas, yet sometimes lack persistence. In contrast, those featured with a conservative style tend to be resistant to change. They prefer to work on familiar tasks using established methods.

Form dimension: Just as with the different forms of government, there are various ways in which individuals govern themselves: monarchic, hierarchic, oligarchic and anarchic. People having a high tendency to monarchic style tend to focus only on one task at a time. Hierarchic and oligarchic individuals tend to distribute their attention and energies over several tasks, with the former being capable of distinguishing priorities while the latter are sometimes disorganized. Finally, individuals featured with an anarchic style prefer to work on tasks that require no system and thus allow for flexibility.

Scope dimension: Governments typically deal with both domestic and foreign affairs, which inspired Sternberg to propose internal and external styles along the scope dimension. Individuals characterized with an internal style prefer to study or work independently, and treat working and learning tasks as priorities; those are relatively external tend to collaborate with others when dealing with a task, and are keen to express their ideas and communicate with others.

2.5.4.2 The relevance of Sternberg's construct to current style frameworks

There have been various attempts to construct style frameworks which can encompass separate style constructs (Kozhevnikov et al., 2014; Zhang, 2013). I have reviewed two style frameworks. One is Zhang and Sternberg's (2005) threefold model of intellectual styles for the reason that this framework has been developed on the basis of examining the attributes of Sternberg's thinking styles, and the 13 thinking styles fit well with the framework. The second is the framework proposed by Kozhevnikov et al. (2014) as it integrates earlier attempts by including both different style families and a hierarchical organization of styles. Kozhevnikov et al.'s (2014) framework probably is the one presenting the current trend in synthesizing styles.

The threefold model of intellectual styles proposed by Zhang and Sternberg (2005) have divided styles into three groups, Type I, Type II and Type III styles. Zhang and Sternberg have conducted a series of studies to examine the attributes of styles, especially the 13 thinking styles proposed by Sternberg (1997). They found the legislative, liberal, hierarchical, global and judicial styles sharing the attributes of "cognitive complexity, nonconformity and low

degrees of structure", and thus have often been classified as one group, namely, Type I styles. In contrast, the conservative, executive, monarchic and local styles normally feature "cognitive simplicity, conformity, authority, and high degrees of structure" (p.204), causing them to be grouped together, namely, Type II styles; anarchic, oligarchic, internal, and external styles may manifest the characteristics of either Type I or Type II thinking styles depending on the stylistic demands of a task, and are named as Type III styles.

The framework proposed by Kozhevnikov et al. (2014) is presented as a matrix (see Table 2.1). The vertical axis of the matrix represents different levels of information processing: perception, concept formation, higher-order cognitive processing and metacognitive processing. The four levels are ranked in ascending order and metacognitive processing are viewed as showing the highest level of information processing. Sternberg's thinking styles are viewed as operating at the higher-order processing level (Evans, 2013; Kozhevnikov et al., 2014). The horizontal axis represents four distinct style families and each of them characterizes a way of adapting to external environments. The four style families are context dependence/independence, rule-based/intuitive processing, internal/external locus of processing, integration/compartmentalization. Kozhevnikov et al. (2014) have not indicated where Sternberg's thinking styles sit within the framework. I tried to locate the 13 thinking styles in the framework based on their descriptions (see Table 2.1). Noticeably, hierarchical, monarchic, oligarchic and anarchic styles are difficult to position in the matrix. Various possibilities can be explored in the future.

The context dependence versus independence family describes the "tendency to perceive events as separate versus inseparable from their physical, temporal, or even semantic contexts" (Kozhevnikov et al., 2014, p. 23). I positioned Sternberg's legislative, executive, liberal and conservative styles within this family. Legislative style indicates people's preference for work or study in their own ways (context independent), while executive style reflects a tendency to follow pre-existing rules (context dependent); liberal style makes people prefer to embrace new and unique ideas (context independent), while conservative style characterizes people who like to stick to tradition and existing contexts (context dependent).

The rule-based versus intuitive processing family describes "an individual's tendency toward directed (driven by rules, analytic) versus aleatoric (driven by salient characteristic or relying on heuristic evidence)" (Kozhevnikov et al., 2014, p. 24). I located judicial style within this family. People characterized with the judicial style prefer to compare and analyse problems, which reflects a rule-driven approach (rational, analytic).

The locus of processing (internal vs. external) family represents whether people tend to process information on their own interiorly, or exteriorly by communicating with others (Kozhevnikov et al., 2014). Sternberg's internal and external styles of course can be located within this family.

The compartmentalization versus integration family represents "a tendency to prefer a compartmentalized, sequential versus an integrative, holistic approach to information processing" (Kozhevnikov et al., 2014, p. 24). Global and local styles proposed by Sternberg (1997) can be positioned within this family. The global style features a tendency to view things as a whole picture and process information globally (integration), while the local style makes people prefer to work on details and concrete information (compartmentalization).

Table 2.1 The place of Sternberg's styles in the conceptual framework proposed by Kozhevnikov, Evans, and Kosslyn (2014)

	Context dependence / independence	**Rule-based / Intuitive processing**	**Internal / External Locus of processing**	**Integration / Compartmentalization**
Perception				
Concept formation				
Higher-order cognitive process	Legislative, executive, liberal, conservative styles	Judicial style	Internal, external styles	Global, local styles
Metacognitive processing				

2.5.4.3 The suitability of the style construct proposed by Sternberg

Sternberg's style construct generally is consistent with my positionalities on styles and more importantly, fits my research needs. Before providing specific reasons, I will firstly clarify the nomenclature issue of style regarding 'thinking style' as used in this paper. Since the style model proposed by Sternberg is used in my research, I thus refer to style in the same way what Sternberg does, namely, thinking style. Sternberg and Zhang (2005) use 'intellectual style' as an umbrella term to encompass specific style constructs. Nevertheless, the term 'intellectual style' more often appears in the work when the style field is being synthesized (e.g. see Zhang, 2013); 'thinking style' is still more frequently employed in empirical studies, where Sternberg's 13 thinking styles are examined with other variables.

Sternberg's thinking styles generally fit my style positions (see Section 2.5.3). Firstly, thinking styles are viewed as sharing the attributes of both stability and variability (Sternberg, 1997). In particular, Zhang (2013) further clarifies the malleability of thinking styles and indicates that thinking styles are more dynamic than static. Secondly, Sternberg's thinking styles are multidimensional and he believes that each individual is characterized with a range of thinking styles simultaneously, rather than merely one. For instance, students may like to work collaboratively with peers, which is high on the external dimension; at the same time, they may like to discover the unknown and thus may fit the liberal style. As a result, they will have characteristics of both external and liberal styles. The 13 thinking styles are proposed along five dimensions, which allow many combinations of style. Thirdly, Zhang and Sternberg have realized the limitation of the matching hypothesis, and starting to embrace the idea of style flexibility. Zhang (2013) has re-interpreted the meaning of matching students' thinking styles with teaching instructions, which is "a two-way feedback process whereby intellectual styles can influence achievement and information on achievement can be used by individuals to modify their styles for future academic/workplace success" (Evans, 2013, p. 170). The importance of self-regulation is also implied by such a feedback mechanism (Evans, 2013).

Reliable and valid measurement tools have been designed to measure Sternberg's thinking styles and they work especially well in Chinese context. Identifying ways of developing valid, reliable and convenient measures of style is one of the key issues within styles field (Evans & Cools, 2011; Evans & Waring, 2012). As for measurement, the Thinking Style Inventory (TSI, Sternberg & Wagner, 1992) together with its two revised versions, Thinking Style Inventory - Revised (TSI-R, Sternberg, Wagner, & Zhang, 2001) and TSI-RII (Sternberg et al., 2007) are designed to measure the 13 thinking styles in Sternberg's theory. These three versions generally demonstrate satisfactory reliability and validity, with their internal consistency improved successively across these three versions (see e.g. Fan & Zhang, 2014). Factor analysis shows that the inventories support the theoretical constructs in Sternberg's theory (Zhang, 2000). Notably, all of his three versions of questionnaires are in English and Chinese, and have been heavily, and probably most frequently, applied in studies in mainland China (see e.g. Fan, 2006; Zhang, 2003; Zhang et al., 2013). This implies that the thinking styles proposed by Sternberg are suitable for use with Chinese students.

There are other style constructs that have been proved to be reliable and valid, some of which are even stronger in terms of measurement criteria, for instance, the Inventory of Learning styles (ILS) designed by Vermunt (1998). The ILS has been found to be valid and reliable in numerous studies (Coffield et al., 2004). Cronbach's alphas of scales in the ILS

show good internal consistency; for instance, a study conducted by Vermunt (1998) with university students indicated that all alpha values were above .70. Also, the ILS has good internal and external validity (Coffield et al., 2004). Confirmatory factor analysis demonstrates that loadings perfectly fit Vermunt's theoretical construct (see e.g. Boyle, Duffy, & Dunleavy, 2003; Vermunt, 1996). However, the ILS is designed especially for university students, and has rarely been tested with school students. A few scholars have made an attempt to use the ILS with secondary school students, yet their results are not entirely persuasive. For example, Slaats, Lodewijks, and Van der Sanden (1999) measured students' learning styles using the ILS in secondary vocational education. They reported that application-directed style and undirected style were not identified, suggesting the inapplicability of the ILS in secondary education. Moreover, individuals' styles may be different across diverse social contexts (Ajisuksmo & Vermunt, 1999). Also very few studies have tested the ILS on Chinese students, and thus there is a risk that it would prove unsuitable if I used it in a Chinese context. Therefore, in terms of style measurement, I view Sternberg's style construct to be the most suitable for my study.

Finally, Sternberg's style construct had been used in my MPhil study and my PhD study has built on the results of my MPhil's. I examined the relationship between thinking style proposed by Sternberg and participation in classroom dialogue in my MPhil, and its results are significant and support my hypothesis. In my PhD work, I added another variable, learning outcomes, to investigate the relationship between the three variables, and sought to understand the learning outcomes after students characterized with different thinking styles had participated in classroom dialogue. The PhD work has built on the findings of my MPhil and thus it was considered better to use the same style construct as my MPhil work had. Considering the above, the approach to thinking styles developed by Sternberg is arguably the most appropriate for use in this study.

2.6 How different thinking styles moderate the relationship between participation and learning outcomes

Different thinking styles have varied characteristics, but will they have different effects on the relationship between dialogue and learning? This study seems to be the first one to use thinking style to explain how students benefit from classroom participation. Very little previous material exists describing how thinking style moderates the relationship, and therefore it is unlikely that this question can be answered by reviewing relevant literature. Instead, I reviewed the ways in which different thinking styles correlate with learning outcomes and participation in classroom

dialogue, respectively. Based on this, it was expected that some idea would be gained of the variety of moderating influences contributed by different kinds of thinking styles.

2.6.1 Relationship of thinking style to learning outcomes

The relationship between thinking style and learning has long been studied, and it has been tested in diverse cultural contexts and educational settings. To examine the influence of thinking style on learning outcome, Sternberg and Zhang have conducted or led a number of studies in mainland China, Hong Kong, America, and some other countries. Both academic achievement and cognitive ability have been tested against thinking styles, providing a comprehensive account of learning outcomes. It is notable that most of the studies were published between 2000 and 2007, about ten years prior to the present. The social and school contexts differ between then and now, and the relationship between thinking style and learning outcomes may vary accordingly. Nevertheless, previous findings lay foundation and reviewing them can help with making assumptions with regard to this research.

2.6.1.1 Relationship between thinking style and academic achievement

Most studies employ academic achievement as a representative indicator of learning outcome. It is generally agreed that thinking style is associated with students' academic achievement; nevertheless, the predictive power of each specific thinking style proposed by Sternberg (1997) in relation to learning varies according across socio-cultural contexts, educational settings and assessment modes (Fan, Zhang, & Watkins, 2010; Zhang & Sternberg, 2001).

Studies have been conducted in the United States, Hong Kong, mainland China, the Philippines and Spain, and typically show thinking style can be used to predict students' academic achievement (Fan et al., 2010). As regards the United States, the judicial and hierarchical styles are consistently associated with high scores across a number of studies. Based on a sample of 67 American university students, Zhang and Sternberg (2001) were not able to identify any positive relationships between learning and the legislative or liberal styles. Instead, styles showing a tendency to self-organization and orderliness (i.e. the hierarchical style) contributed to higher learning outcomes. Similarly, Zhang (2002d) conducted a study with 212 American university students, and collected their GPAs (grade point averages) as evidence of their academic achievement. She found that students who achieved higher scores were those characterized with norm-conforming styles (i.e. executive style), a preference for systematic arrangement of multiple tasks (i.e. hierarchical style), or analytical styles (i.e. judicial style). By contrast, the legislative style was negatively related to academic scores.

As regards the situation in mainland China, higher academic achievement seems to be positively associated with a preference for working on details and following existing rules. Zhang (2007) conducted a study with 452 students from a senior secondary (sixth-form) school in rural China. Achievements in Chinese, mathematics and English were selected for study, as these three subjects are amongst the most important in the Chinese curriculum. Zhang found that the local style consistently facilitated achievement in all three subjects, which arguably reflected the fact that it was essential for these Chinese students to pay attention to concrete knowledge in order to achieve high scores. In addition, the legislative and executive styles were positively related to scores in Chinese, while the conservative style showed a negative correlation with scores in Chinese.

In Hong Kong, thinking styles characterized by an orientation towards conformity, orderliness and thinking internally have emerged as more likely to have positive relationships with academic achievement, while styles that feature creativity and uniqueness are seemingly not effective in attaining good test scores (Zhang & Sternberg, 2001). For instance, Zhang and Sternberg (1998) conducted a study based on 622 freshmen from the University of Hong Kong. The TSI was used to measure thinking styles and the scores attained in the university entrance examination served as a reflection of academic achievement. Zhang and Sternberg found that the executive, conservative, hierarchical and internal styles were positively associated with academic achievement, while the legislative, liberal and external styles were negatively associated with test scores. A study conducted by Zhang (2004) obtained similar results. Students from two Hong Kong secondary schools were involved in Zhang's study, with the 82 participants being from Grade 9 (16 years old). Zhang collected scores for 16 subjects covering social sciences (e.g. economics and public affairs, geography), humanities (e.g. Chinese history, music, Chinese language) and natural sciences (mathematics, physics, chemistry). Zhang indicates that the hierarchical style was the strongest predictor of academic achievement, as it was identified as being positively related to the scores in 10 subjects, most of which belonged to the social sciences and humanities; the judicial style was most strongly predictive of learning in the natural sciences. Apart from the above two styles, the monarchic style was identified as being positively correlated with scores in design and technology.

The situations in Spain and the Philippines are generally similar to that of Hong Kong. Cano-Garcia and Hughes (2000) tested the relationship with 210 Spanish college students and found that thinking style could be used to predict academic achievement. Cano-Garcia and Hughes used the TSI to measure thinking styles, and grade point averages (GPA) from tests in high school served as evidence for academic performance. They found that students whose

achievements were higher were more likely to adhere to existing rules (i.e. executive style) and work individually (i.e. internal style), while they were unlikely to be those who preferred creative ways of studying (i.e. legislative style). A similar situation was also observed by Bernardo, Zhang and Callueng (2002) in the Philippines. The participants in the study were 429 Filipino students, among whom students characterized with executive, conservative, judicial, hierarchical and internal styles had a greater chance of achieving higher GPAs.

As summarized in Table 2.2, in most studies published before 2010 thinking style has found to be related to, and to have predictive power for, academic achievement (Fan et al., 2010; Jehng, 1997). Yet, the effects of the specific styles on achievement scores vary across socio-cultural contexts and educational settings. Moreover, most studies focus on university students, while how the relationship with school students is less well-known.

Table 2.2. A summary of the relationship between thinking style and academic achievement

Specific style	**US**	**Mainland China**			**Hong Kong**				**Spain**	**Philippines**
	Average	Maths	Chinese	English	Average	Social science	Humanity	Science	Average	Average
Legislative	-		+		-		-		-	
Judicial	+					+	-	+		+
Global							+			
Liberal	-				-		-			
Hierarchical	+				+	+	+	+		+
Executive	+		+		+			-	+	+
Conservative			-		+	+	+	+		+
Local		+	+	+		-	-	-		
Monarchic							+			
Oligarchic										
Anarchic						+				+
Internal					+	+			+	+
External					-	-				

2.6.1.2 Relationship between thinking style and cognitive ability

There are a small number of studies investigating the effect of thinking style on cognitive ability. Results concerning the relationship between thinking style and cognitive ability are generally consistent across different studies, reporting little or no significant results (e.g. Sternberg, 1997; Zhang, 2002c). One example is a study conducted by Grigorenko and Sternberg (1997), with 199 students enrolled in a Yale Summer School serving as the sample. These participants were high school students, like the sample in my study. Students' abilities were assessed using the Sternberg Triarchic Abilities Test (STAT), Level H, designed for students aged 16 years and above (Sternberg, 1993). Thinking styles were evaluated on the

basis of a set of thinking-style tasks and a Thinking Style Inventory (Sternberg & Grigorenko, 1995). It was found there was no significant relationship between any of the thinking styles and cognitive ability.

Zhang (2004), tested the relationship in Hong Kong, with 250 secondary school students involved. All the participants responded to the STAT, Level H, which was used to measure cognitive abilities. Thinking style was evaluated using the TSI. Partial correlation analyses indicated that there was a lack of significant relationship between thinking style and cognitive ability after controlling students' age, gender and school class level.

2.6.2 Relationship of thinking style to participation in classroom dialogue

In my MPhil study, the relationship between thinking style and participation in classroom dialogue has been investigated. I collected data relating to 170 Chinese secondary school students, with an average age of 15-16 years. I classified classroom participation[2] with reference to participation frequency and quality. Four categories were proposed when I considered participation frequency: teacher initiates & student contributes, teacher initiates & student does not contribute, teacher does not initiate & student contributes, and teacher does not initiate & student does not contribute. Accuracy and the cognitive level of dialogue were used to measure participation quality. I found that students characterized with judicial and external styles preferred to participate in classroom dialogue through talking, while students characterized with executive, conservative and internal styles tended to remain silent and rarely talked in the classroom. From my MPhil study it can be seen that students with different thinking styles tend to engage in classroom dialogue using their preferred talking or listening strategies.

2.7 Limitations in previous research and my proposed contributions

After reviewing previous research, there are several main limitations that are addressed in my study, which are summarized as follows.

2.7.1 Limitations regarding accounting participation in classroom dialogue

The first limitation concerns accounting for participation in classroom dialogue. Talk is constantly treated as the sole index of classroom participation, and very few studies include

[2] In my MPhil work, I defined participation as verbal contributions, while excluding listening.

listening/attentive silence as a form of participation. Recently, there has been an awareness that silent participants should not be overlooked, as they are likely to pay attention to course content, make good use of classroom dialogue and learn well, for instance, in the study conducted by O' Connor et al. (2017). However, an empirical problem exists that there are few tools for measuring listening/attentive silence efficiently, which in a way blocks research into its implications.

In previous studies, measurement of listening in classroom dialogue has limitations. When listening is considered in the study of classroom dialogue, scholars usually take a qualitative approach and interview silent students about what they think of listening. Typical questions include 'How do you view your participation?' 'Why do you stay silent in classroom dialogue, and not contribute to talk?' 'How does listening affect your learning?' From the interview transcripts, scholars may able to pry into the ways that students are involved in classroom dialogue through listening. Nevertheless, there is a lack of quantitative means to measure listening/attentive silence. Results achieved from interviews may not be generalizable to wider contexts, and it is difficult to examine the relationship between listening and other variables, such as learning outcomes. A few studies have made an attempt to measure silence quantitatively, and that of O' Connor et al. (2017) is one such study. However, they did not measure attentive silence directly, but inferred it from the measurement of talk. The number of words spoken by students was counted, and those contributing more words were viewed as talkative students, while those who contributed few words were regarded as silent participants. Designing a questionnaire to measure listening in classroom dialogue is therefore a matter that needs to be addressed, as I do in my study.

2.7.2 Limitations regarding accounting for learning outcomes

The invention of an instrument that can assess learning outcomes in a reliable and valid manner is essential and indispensable for studying the relationship between classroom dialogue and learning outcome, both for "theory testing purpose and for the legitimization of dialogic classroom practice" (Vande Veen & Van Oers, 2017, p. 2). Until now most studies on classroom dialogue have focused on subject matter learning outcome, and academic achievement is usually measured when scholars assess learning outcomes (Vande Veen & Van Oers, 2017). This is understandable when academic scores are easy to obtain and important for students. However, it has been found that key cognitive abilities, such as analysis and creativity, are less emphasized or obvious in examination papers. There is a need to include an assessment of cognitive ability as well as academic achievement. My study considers both in order to

evaluate students' learning outcomes. Moreover, when conducting the literature review, I found that very few tests of cognitive ability have been shown to be reliable and valid, and to be easy to use in practice. A cognitive test designed by Sternberg matches my study requirements from theoretical perspective. In practice, it has been used with Chinese students before, although not many, with satisfactory results. My study hopes to testify its reliability, validity and suitability for the use with Chinese school students. Depending on the results, it may offer researchers and teachers an alternative way to assess students' learning.

2.7.3 Lack of research evidence on high school students

Students in the age range between 17 and 19 years, namely those in high schools, are rarely included in studies of either thinking style or classroom dialogue, which is why I decided to focus on this particular age group. As regards studies of thinking style, most of them choose university students as research objects. There are reports about the characteristics of how university students tend to think, and how their thinking styles correlate with learning process and learning outcome. Yet less is known with school students, which is expected to be solved in my study.

As regards studies of classroom dialogue, many of them have mainly chosen Western students as study sample, and focus on young pupils (see Howe & Abedin, 2013). When examining the relationship between individual characteristics and participation in classroom dialogue, it have been known that many individual characteristics can affect primary or secondary school students' classroom participation, of which gender, ethnicity and academic achievement receive most attention (Howe & Abedin, 2013). Pupils of different genders, ethnicities or achieving diverse scores are likely to make diverse contributions to classroom talk. Yet it is unknown whether the above findings are applicable to high school students, and which individual characteristic can be used to explain their varied participation behaviours. This study attempts to fill this gap.

Moreover, although it is acknowledged that classroom dialogue is essential for young pupils, students in higher grades, namely, those in high schools, also need to make good use of classroom dialogue as it is found to be helpful in encouraging thinking, understanding and learning. To extend its function, different approaches (i.e. talking or listening) may be employed by students to become involved in classroom dialogue. High school students aged above 16 years generally have more mature self-understanding. They are more likely to employ the right learning method based on their needs and individual characteristics, rather than

following the teacher's orders. High school students' participation behaviour, either talking or remaining silent, may tend to reflect their choices. Choosing this group of students as the study sample may allow me to discover the reasons that impel students to talk or remain silent, and produce more interesting findings.

2.7.4 Limitations regarding how to make use of dialogue to promote learning

Classroom dialogue is a frequently used method for teaching and learning, and great value is attached to its role in promoting thinking, understanding and learning. Previously, talk has been viewed as a main indicator of classroom participation and many scholars emphasize its importance for promoting learning achievement (e.g. Mercer, 2008). Yet only a small number of studies have demonstrated clear statistical evidence of the positive relationship between talk and learning outcomes. When they do, the evidence is usually attached to an experimental approach and results from intervention in teaching or learning methods. There is a need to examine how talking functions for learning in normal class settings, and this is what has done in my PhD work. If significant positive results are reported, we can probably be more emboldened to vote for talk. As well as talking there are scholars who argue that listening can be regarded as useful in classroom dialogue, and suggest that it may also facilitate learning outcomes (e.g. O' Connor et al., 2017). Yet very little empirical evidence exists that describes how listening in classroom dialogue correlates with learning outcomes. Thus my intention was to fill this gap by offering empirical evidence.

Moreover, how each individual student should makes use of classroom dialogue remains an unsolved problem, as talking and listening do not serve all students equally well. Previously, individuals' characteristics seem to be overlooked when considering the function of dialogue. In the process of knowledge construction through dialogue, students process information actively rather than merely giving passive responses to stimuli, which means that "individuals differentially and selectively attend to and process learning materials based on their prior knowledge, understanding, values, styles and resultant motivation" (Renzulli & Dai, 2001, p. 23; Vermunt, 1998). Because of their different personal characteristics, students consciously choose what to learn and how to learn (Vermunt, 1996, 1998). Individual characteristic plays an essential role in explaining how students participate in classroom dialogue and how they benefit from this participation, which needs to be considered.

As students' have different ways of processing information, they may participate in dialogue in a variety of ways, with some being talkative, while others tend to listen more. Previously, thinking style has rarely been used to investigate the relationship between

participation in classroom dialogue and learning outcomes. My study is a pioneer in this respect, and makes a bold hypothesis that thinking style may affect the learning outcome a student achieves from participation in classroom dialogue. Thinking style is an essential aspect of individual differences, and has been given greater emphasis by both researchers and educators. In a whole-classroom setting, students with certain kinds of thinking styles may find that talking is more likely to bring them good learning outcomes; while for some others, listening in classroom dialogue may be more suitable for their learning. Depending on the results, my study may be able to provide teachers and students clear instructions on how to make use of classroom dialogue efficiently.

2.8 Research questions and hypotheses

2.8.1 Research questions

Based on the literature reviewed above, the overarching aim of this study is to add to knowledge about how classroom dialogue can be the setting in which high school students' learning takes place. At a general level the aim is to examine how participation in classroom dialogue correlates with and influences learning outcomes. At the individual level the intention is to investigate whether and how thinking styles moderate the relationship between participation in classroom dialogue and learning outcomes. In other words, how much knowledge will students characterized by different thinking styles obtain from participation in classroom dialogue? To help address these issues the following specific questions are addressed.

1) How do different forms of participation, namely talking and listening, in classroom dialogue relate to learning outcomes, with a focus on high school students?
2) How are thinking styles correlated with participation in classroom dialogue, including both talk and listening? Can the significant relationships found in MPhil work be replicated with high school students?
3) How does thinking style relate to learning outcomes in high school students?
4) How do different thinking styles moderate the relationship between participation in classroom dialogue and learning outcomes? To be more specific, which thinking styles will add to or adversely affect the relationship between talk and learning outcomes? Which thinking styles will add to or adversely affect the relationship between listening and learning outcomes?

5) How do students view the effect of thinking style on the relationship between participation in classroom dialogue and learning outcomes?

2.8.2 Making hypotheses

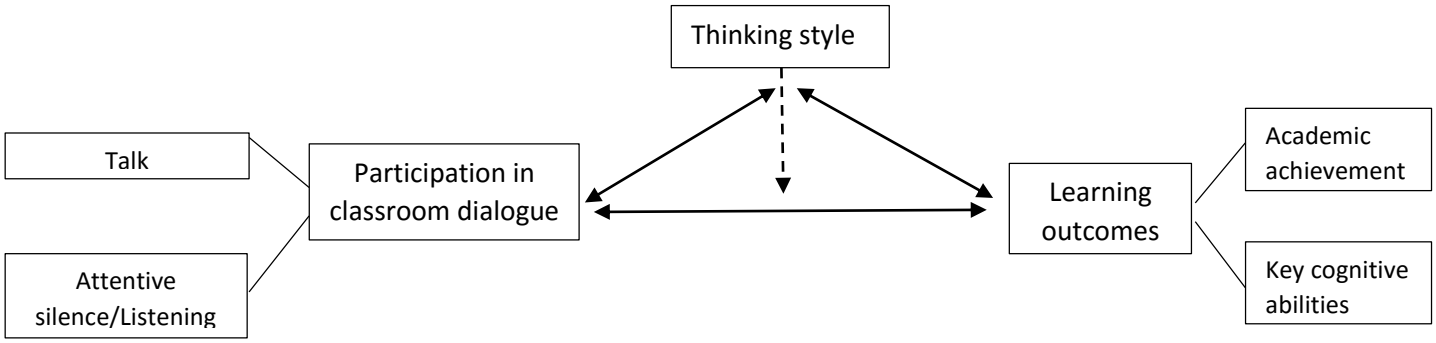
I propose the hypotheses that talking and listening may both be associated with positive learning outcomes. Moreover, the relationship between participation in classroom dialogue and learning outcomes may be systematically moderated by thinking styles. In other words, thinking styles may predict how much knowledge students acquire from participation in classroom dialogue. Participating in classroom dialogue through talk may be beneficial for the learning outcomes of students with some kinds of thinking style; as regards students with other kinds of thinking style, talking may be less helpful. Similarly, students with some thinking styles are more likely to benefit from listening to dialogue, while others are not.

I have developed a model to illustrate the potential relationship between thinking style, participation in classroom dialogue and learning outcomes (see Figure 2.1), in which such participation is seen as an independent variable or a main predictor, learning outcome is taken as a dependent variable or criterion, and thinking style is a moderating variable. A moderating variable refers to "one which systematically modifies either the form or the strength of the relationship between a predictor and a criterion variable" (Sharma, Durand, & Gur-Arie, 1981, p. 291). Introducing thinking style as a moderator variable may allow for greater insights into understanding the relationship between classroom participation and learning outcomes.

The model in Figure 2.1 is how a moderation model typically appears (see Cohen et al., 2003), with the potential moderator placed in the middle and connected by a dotted line to the main relationship between classroom dialogue and learning outcomes, which indicates the potential influence of thinking style on how people benefit from talking and listening. Participation in classroom dialogue and learning outcomes are latent variables, which means that they cannot be observed directly but are rather inferred from other observed variables (Field, 2009). Straight lines are normally used to connect observed variables to their corresponding latent variables. Talking and listening are two observed variables, through which it is possible to infer students' participatory performance. This means that in my study, participation in classroom dialogue was shown and assessed through two forms, talking and listening. Similarly, learning outcomes were manifested and assessed in terms of students' academic achievement and their level of cognitive abilities after classroom participation. A double-arrow line connecting two variables was used to show a bi-directional relationship. The

literature reviewed in Chapter 2 suggested three pairs of relationships: participation in classroom dialogue is likely to correlate with learning outcomes, there is a potential relationship between thinking style and participation in classroom dialogue, and thinking style tends to correlate with learning achievement. Thus, the model and arrow lines were drawn in the following ways.

Figure 2.1. A model of the relationship between participation in classroom dialogue, thinking style and learning outcomes



All hypotheses have been made in the contexts of whole-class dialogue, in which 40 students or more share one 40-minute class. This circumstance seems unlikely to provide every student with sufficient time to express their views after careful consideration (Rop, 2003). Because of the constraints of time and opportunity, students have to make a choice either to talk or remain silent. The hypotheses relating to a recommendation to remain silent do not necessarily imply that talk is less important or should not be encouraged. Instead, they aim to help educators pay attention to the different functions of talk and silence in a whole-class learning environment. Teachers should be aware that students' thinking styles are different and be sensitive to the fact that students may choose different strategies in order to learn well. It is suggested that teachers and educators should try to understand students' particular behaviours, rather than judging them according to an absolute standard (Li, 2004). If a study concentrates on small-group dialogue in which sufficient time and opportunities are available for almost all students to participate (see Mercer & Sams, 2006), hypotheses will be different and talk may be a method that is worth advocating for all.

Chapter 3. Methodology

This chapter outlines how I designed my study in order to address the research questions. It begins by illustrating the main philosophical stances of relevance, with pragmatism appearing to be the most appropriate. In alignment with pragmatism, a mixed-methods research design was employed. I then introduce the participants and describe the contexts in which I undertook my fieldwork. Next comes sections on the collection of data concerning thinking styles, talk and listening in classroom dialogue, and learning outcomes, which were subjected to quantitative analysis. This is followed by a description of data collection for qualitative analysis.

3.1 Paradigm

As stated by Creswell (2009), an essential element to consider when conducting a study is the nature of the research, which is termed the 'paradigm'. Paradigms are concerned with philosophical assumptions and stances, and are defined as "systems of beliefs and practices that influence how researchers select both the questions they study and methods that they use to study them" (Morgan, 2007, p. 49). Paradigms are associated with research questions and offer a justification for how to conduct research (Crotty, 1998).

According to Creswell (2009), there are three paradigms that are commonly viewed as mainstream: post-positivism, pragmatism and constructivism. Belief in one of these three stances correspondingly leads to embracing a quantitative, mixed-methods, or qualitative approach respectively. The post-positivist approach is grounded in the belief that knowledge exists externally and independently of human experience and convictions. Post-positivists claim that knowledge can be learned and developed through careful observation and measurement. Doing research is a process of making claims and then verifying or falsifying these claims on the basis of objective facts. Standing at the opposite end of the continuum is constructivism, which is a paradigm that assumes that meanings are constructed by human beings when they interact with the outside world. Meanings and interpretations are varied and multiple, leading researchers to explore the complexity of beliefs and the underlying mechanisms of behaviour. Constructivism is often used to inform qualitative research designs.

Unlike the above philosophical stances, pragmatism is not committed to any one system of philosophy. Instead, it is a world-view that "arises out of actions, situations and consequences" and assumes truth is what works at the time (Creswell, 2009, p. 10). Pragmatists emphasize research problems and use pluralistic approaches to understand the problems (Morgan, 2007; Rossman & Wilson, 1985). Pragmatism has been heavily used to instruct

mixed-methods research (Teddlie & Tashakkori, 2009), which has become increasingly popular in the field of classroom dialogue research (Howe & Abedin, 2013).

I based my research on the assumptions of pragmatism for three main reasons. Firstly, both quantitative and qualitative approaches have inherent "value and usefulness in special contexts", and it is inappropriate to hold a dualist view and weigh one paradigm against another (Badley, 2003, p.306). Merely embedding research in one approach may not allow the researcher to capture the trends or details of a situation, and it may prove to be insufficient to answer the research questions. In contrast, pragmatism takes a comprehensive stance, encompassing multiple approaches and methods that are useful in solving a problem. This is helpful in studies aiming to understand a complex phenomenon. Secondly, more insight would be gained from pragmatism embedded in a mixed-methods approach. When applied to educational research, a quantitative approach offers powerful techniques for exploring relationships between different variables, and finding potential factors that affect behaviours; a qualitative approach is useful when describing and making sense of a social phenomenon from a subjective viewpoint, and such an approach is usually used to answer the question 'why'. Encompassing both approaches endows researchers with comprehensive insights into a phenomenon.

The aim of my study was to explore the relationship between thinking styles, participation in classroom dialogue and learning outcomes. Based on pre-existing theories and studies, it was deduced that thinking style may be a factor that moderates how students benefit from participation. Testing this hypothesis lies at the core of my research aims and thus a quantitative approach was necessary. At the same time, a qualitative approach was seen as potentially helpful in making sense of the relationship from subjective perspectives and potentially offered the possibility of gaining deep understanding of students' motives for choosing either to talk or listen. Thus, both quantitative and qualitative approaches were regarded as helpful, implying that a philosophical stance which encompasses both would be especially suitable for my research design. Pragmatism, a stance proceeding from the needs of the research questions, met the requirements of the research and thus was most appropriate to serve as the philosophical basis of my study.

3.2 Research design

A research design is a systematic plan of how to conduct research, including strategies and procedures underlying the choice of specific methods (Crotty, 1998). The selection of a design

is bound up with the choice of paradigm (Crotty, 1998). In alignment with the stance of pragmatism, I employed a mixed-methods research design. As described by Johnson, Onwuegbuzie and Turner (2007, p. 123), a mixed-methods design is a type of plan in which a researcher "combines elements of qualitative and quantitative research approaches (e.g. use of qualitative and quantitative viewpoints, data collection, analysis, inference techniques) for the purpose of breadth of understanding or corroboration".

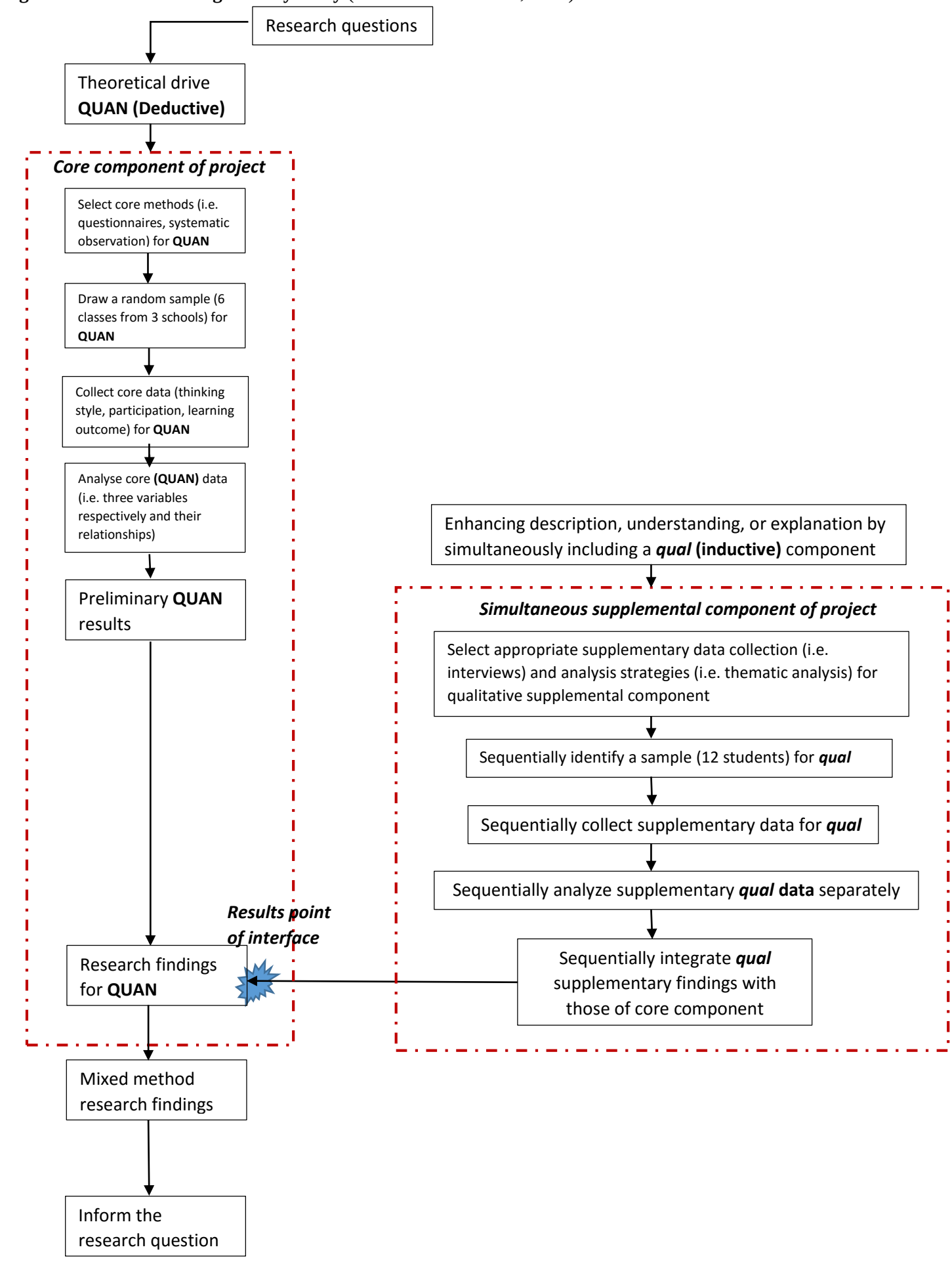
According to Creswell (2009), there are three elements that should be considered when designing a mixed-methods study: timing, weighting and mixing. As regards timing, two situations occur, either in parallel or in sequence, when quantitative and qualitative data are collected. Parallel mixed designs mean that the two kinds of data are collected simultaneously or with some time lapse, addressing relevant aspects of the same basic research questions (Morse, 2003; Teddlie & Tashakkori, 2009). In contrast, data are collected in a chronological manner in sequential mixed designs, with one strand emerging from, or depending on, the results of the other (the qualitative strand followed by the quantitative strand, or *vice versa*) (Morse, 2003; Teddlie & Tashakkori, 2009). My study aimed to investigate the effects of thinking style on the relationship between participation in classroom dialogue and learning outcomes. The quantitative component was designed with the aim of identifying the patterns. Once this core component had been addressed, a supplemental component (qualitative methods) was then to be used to enhance understanding of why the pattern occurred. The qualitative step needed to be based on the results of the quantitative one. Thus sequential mixed-method design was appropriate for my study.

The second element requiring consideration is whether priority should be given to the quantitative or qualitative strands in a particular study. Theoretical drive plays a critical role here (Morse & Niehaus, 2007). Research has its overall purposes, which oblige researchers to "identify the study as using an inductive or deductive theoretical drive" (Morse & Niehaus, 2007, p. 42). As stated by Richards and Morse (2007), the inductive drive is usually associated with an overall purpose of making sense of a phenomenon and eliciting meanings. If induction serves as the theoretical drive, qualitative methods should be accorded a heavier weighing. Conversely, deduction often relates to the purpose of testing hypotheses based on *a priori* facts or theories. Research built on deduction emphasizes quantitative methods. A quantitatively driven mixed-methods design was suitable for my study. This was because the overall purpose of my study was to investigate whether thinking style moderates the relationship between participation in classroom dialogue and learning. This assumption was motivated by existing research evidence and theoretical propositions. Appropriate methods were then selected to

verify or disprove the hypothesized model. Although I used qualitative methods to learn about students' views regarding classroom participation, this was merely for the purpose of compensating for the inadequacies of quantitative methods in understanding data. The overall purpose of my study was deductive, regardless of the supplemental qualitative components. Thus, a quantitatively driven mixed-methods design met my research purpose and was applied in my study.

The last element is mixing, which concerns when and how quantitative and qualitative approaches should be combined (Creswell & Clark, 2007). There are several points at which mixing might occur: data collection, data analysis, or data discussion (Teddlie & Tashakkori, 2009). As regards my research design, I collected and analysed quantitative and qualitative data separately, and then mixed them in the findings phases. I integrated supplementary findings collected using qualitative methods with those collected employing quantitative methods. At the same time, I kept the format of qualitative description and did not transform qualitative data into a numerical format. This type of mixture was for two main reasons: one was that I employed semi-structured interviews to understand why students with certain kinds of thinking style preferred to participate in particular ways and to explore if this had any influence on their learning outcomes. Students' views and reflections are diverse. It is hard to code the descriptions with only a few pre-set categories, as there could be the risk of missing essential information. Moreover, using qualitative descriptions rather than transforming the data into numerical information makes up for the inadequacies of statistical results. This helps researchers gain deeper insights into a problem. The overarching research design, procedures and strategies, are illustrated in Figure 3.1

Figure 3.1. Research design for my study (see Morse & Niehaus, 2009)



3.3 Research context and participants

I conducted my fieldwork in a medium-sized city, Gongguan, in mainland China. Given that my thesis will be a public document, I used pseudonyms, No. 1 Middle School, No. 2 Middle School and No. 3 Middle School, instead of the real names of the three schools to protect their confidentiality. Gongguan is situated in the south-eastern part of China, close to Hong Kong. Gongguan's city administration is considered progressive in the way that it seeks foreign communication and investment. The city has built up close relations with other areas, both national and international. People there are likely to embrace change and are open to new things. At the same time, the economic situation of Gongguan is developing very quickly, and the city is well-known as the home of world industrial manufacturing. Recently, the local government has realized that it is insufficient merely to introduce or imitate advanced technology from abroad; technological innovation and application are viewed to be more important. In order to meet the needs of rapid economic development, the city has placed high demands on people's intelligence, particularly emphasizing the importance of reasoning and creativity. The local education agency and schools have launched a series of measures to implement 'character-building' education. In particular, employing classroom dialogue in teaching and learning has been encouraged actively. New education ideas and methods are also accessible. Thinking style, a relatively novel idea in mainland China, has been accepted and welcomed by the local education agency and schools. In view of the above, I chose the city Gongguan for conducting my research.

Three high schools were involved for my data collection, for the reason that in Gongguan where I conducted fieldwork, schools are generally divided into three levels. Schools labelled 'higher-level' generally have better teachers and teaching facilities compared with those labelled 'lower'. Before entering high school, students in Gongguan need to take a matriculation examination, and those achieving high scores have a good chance to be accepted by a higher-level school, while those achieving low scores will enter relatively low-level schools. Within each level of schools, I selected one randomly and then approached the principal of the school to gain his/her approval. The principals of the three selected schools all agreed to participate in my study. The three schools selected in my study were from the three different levels, with the No. 1 Middle School ranked at the highest level, the No. 2 ranked in the middle and the No. 3 Middle School ranked as the lowest.

Students from grade 11 in these high schools were selected as the research sample. There are three grades in high school education, and students in grade 11 are in the second of these

grades. High school education in China is equivalent to the foundation or A-level course in the UK education system. Students move up from secondary school education and after three years' study are expected to pass college entrance examination in the final year to enter the university of their choice. The college entrance examination is very important for Chinese high school students, and is often portrayed as the one that really matters with respect to their future life. All students across the nation take the examination on the same days, using the same examination papers. In order to achieve good marks in the examination, teaching and learning in high school are conducted according to a standard syllabus, which means using specified textbooks, proceeding at the same pace, and employing similar teaching and learning methods. Mastery of content in the textbooks is necessary, and in addition the ability to reason and analyse are highlighted. Creativity and application of knowledge, although mentioned in the syllabus, are not reflected fully in the standardized examination.

In high school education, all students study the same courses in the first year, including general courses (i.e. mathematics, Chinese language and English), science courses (i.e. physics, chemistry and biology) and liberal arts courses (i.e. history, geography and politics). From the second year, students begin to decide whether to focus on science or the liberal arts. Students who prioritize science will study general courses and science courses in the second and third years; those prioritizing the liberal arts will study general courses and liberal arts courses. Core courses and learning content are usually delivered in the second year. Most of the third year will be used to review, prepare and train for the final examination.

I chose students from the second year as my study sample for several reasons. Firstly, the average age of grade 11 students is 18 years, and they are already adults according to Chinese law. This indicates that they are capable of making choices about their learning, including identifying the most appropriate strategies and goals to meet their needs and deciding whether classroom dialogue is an optimal choice for learning (Garner, 2000; Velmurugan & Balakrishnan, 2011). This allowed me to make reliable observations of whether students were taking the initiative as regards participation in classroom dialogue. Secondly, as stated above, in my research context most courses in which teachers present new knowledge are delivered during the first and second years. Compared with teachers of courses that review knowledge, second-year teachers would be more likely to leave time for students to talk in class, allowing for the sharing and exploration of ideas when new courses were delivered; students would be more active in classroom talk. Observing the lessons in grade 11 would be more likely to capture students' participation in classroom dialogue. In comparison, lessons from grade 12 seem likely to be less appropriate. Indeed during my pilot study, I observed a lesson in the

selected school and found that students from grade 12 were busy preparing for examinations and very few students talked in class. Grade 12 would be unlikely to supply abundant data on participation. Further, students from grade 11 have already been through one year in high school, and have generally adapted to its teaching methods. Their thinking styles would not easily change in an environment that remained relatively stable, and therefore could be related to participation and learning outcomes for measurement. By contrast, grade 10 students had just entered high schools in the Autumn term when I conducted my fieldwork, and might not have settled down completely. Data collected from group 10 students would be less likely to reflect the features of classroom participation of high school students. For the above reasons, students from grade 11 were considered the most suitable to serve as study sample in my study.

In each school, two classes from grade 11 were selected for study, so there were six classes involved in total. This choice was made after taking into account two main issues. Firstly, sufficient data needed to be ensured, especially for regression analysis. The larger the amount of data collected (normally above 200), the more likely I was that significant results would appear in statistical analysis. Given that the number of students within each class was generally around 55, the number of school classes involved in my study needed to be at least six. I also took practical issues into account. My PhD fieldwork was a relatively large project, with two questionnaires and one test needing to be completed, together with classroom observation. With the limitation of funding and time, I could not possibly cover more classes, otherwise it would not be manageable. Thus only six classes were involved in my study in total. In No. 1 Middle School, there were 18 classes in grade 11, 15 of which were science classes (i.e. students focusing on science) and the remaining three were liberal classes (i.e. students focusing on the liberal arts); No. 2 Middle School had 13 science classes and four liberal classes from grade 11; similarly, in No 3 Middle School, there were 10 science classes versus two liberal classes. Thus, most students in all three schools were taking the scientific approach, which is a common phenomenon in Chinese high schools. Given the small number of liberal classes, it might not have been possible to represent the behaviours and characteristics of the majority if I had chosen from them. I thus decided to choose two classes randomly from grade 11 science classes in all three schools. I named these Class A, B, C, D, E and F respectively. Of the students in the selected classes, three expressed an unwillingness to engage in my study, and thus were excluded. Apart from the three, all students in the six classes served as participants. There were 289 participants involved altogether, with 97, 96 and 96 students from the three schools respectively. All participants were Chinese.

3.4 Collection of data concerning thinking style

I used a self-report questionnaire, the TSI-RII (Sternberg, et al., 2007), to measure students' thinking styles. Data collected via questionnaires are usually obtained in, or readily transformed into, numerical form, and are therefore amenable to quantitative analysis (Aliaga & Gunderson, 2002). Moreover, self-report questionnaires are generally advantageous in collecting data that are hard to observe (Rea & Parker, 1997), such as those concerning attributes and attitudes (Hartas, 2010a).

The TSI-RII is the second version of a questionnaire designed to measure the 13 thinking styles proposed by Sternberg (1997). It has been applied in a variety of studies focusing on Chinese students, with most studies employing it with students who are over 16 years of age. Its reliability and validity are satisfactory (see e.g. Fan & Zhang, 2014; Zhang & He, 2011; Zhang, et al., 2013). In terms of internal consistency, data reported to date show good internal consistency with Cronbach's alphas for all 13 thinking styles above .60, including the Chinese version and the English version (see e.g. Fan & Zhang, 2014; Higgins & Zhang, 2009; Zhang & He, 2011; Zhang et al., 2013). In particular, one of the TSI-RII's designers, Zhang, has tested the Chinese version with students in mainland China on a number of occasions and reported sound results (e.g. Zhang, 2009, 2010). For instance, Zhang (2010) investigated the contribution of thinking style to cognition, with 424 (101 male and 323 female) Chinese university students as participants in Shanghai, mainland China. The participants were aged between 17 and 32, with 20 years being the average. Among these students, there were 163 first-year students, 166 second-year students and 95 third-year students. Furthermore, the students were from three academic fields: biology, education and finance. She collected the data concerning thinking style with the help of the TSI-RII and found the alpha coefficients for the 13 thinking styles were all above .65, indicative of internal consistency.

Studies led by other scholars have also resulted in satisfactory results. One example is the work of Fan and Zhang (2014), in which 341 Chinese students in a Shanghai university in China volunteered to participate. Among them, 151 were male and 190 were female. The average age of the participants was 19 years. This time they covered a wider range of academic majors, with 28.5 per cent being from humanities and social sciences, 41.5 per cent from science and engineering, 22.4 per cent from economics and management, 6.2 per cent from medicine and pharmacy, and 1.5 per cent from the arts. The TSI-RII was used to measure the students' thinking styles. Fan and Zhang found that all thinking styles measured by the TSI-RII had satisfactory internal reliabilities, with alpha coefficients above .67. Based on the

published studies, the TSI-RII appears to be an acceptable instrument in terms of the measurement of thinking styles.

There are a few things that need to be noted when drawing conclusions about the TSI-RII's reliability. Up to now, almost all published studies have tested the instrument with university students, while none of them has used it with secondary or high school students. Also, the work recently conducted by Zhang and her colleague using the TSI-RII for the measurement of thinking styles was all based in one city, Shanghai, China. In the published papers, the researchers did not give a reason for this selection. Was it because they had connections with universities in Shanghai? Or does Shanghai, as the most important economic power in China, have special strengths in terms of the study of thinking style? I considered it necessary to test the instrument on school students and in a city other than Shanghai. In my MPhil study, I used the TSI-RII to measure the thinking styles of secondary school students in Hebei Province, mainland China. My MPhil study obtained low Cronbach's alphas with respect to two styles: anarchic (.55) and monarchic (.55). This might have been due to the fact that the participants were secondary school students, and with an average age of 16 they might have been lacking in a mature self-understanding of their thinking styles. The self-report questionnaire TSI-RII requires a certain level of metacognitive capacities to reflect stable patterns of preferences and behaviors (Schwab-Stone, Fallon, Briggs, & Crowther, 1994). There is great potential for improvement in my PhD study since 18-year-olds acted as participants. It was expected that the TSI-RII would prove to be reliable in terms of measuring high school students' thinking styles in Gongguan.

Research has generally, although not entirely, supported the construct validity of Sternberg's style constructs when using the original Thinking Style Inventory and its two revised versions with students and teachers from a number of different cultures, including Hong Kong, mainland China, the Philippines, and the United States (e.g. Bernardo, Zhang, & Callueng, 2002; Betoret, 2007; Dai & Feldhusen, 1999; Kaufman, 2001; Zhang, 2005; Zhang & Sternberg, 1998). For instance, Betoret (2007) conducted an exploratory factor analysis, with oblique rotation for thinking styles. He then achieved a five-factor model, which was generally consistent with Sternberg's style constructs. The composition of the factors was as follows. Factor 1 was highly loaded by the legislative (0.77), judicial (0.76), liberal (0.73) and hierarchical (0.66) styles; Factor 2 encompassed the local (0.87) and global (-0.85) styles; Factor 3 had high loadings of the executive (0.73) and conservative (0.75) styles; Factor 4 had a high positive loading of the external style (0.88) and a high negative loading of the internal style (-0.81); and Factor 5 was made up of the oligarchic (0.81) and anarchic (0.79) styles.

More notably, the inventory and its two revised versions have been associated with good external validity, which was assessed by examining not only a number of constructs that belong to the family of work on styles but also a few constructs that are considered to be related to thinking styles. As summarized in Zhang and Sternberg (2005), since 1996, Zhang, Sternberg, and their colleagues have conducted three main series of research studies based on the theory of mental self-government in cross-cultural settings. The first, and also the most basic, series of studies investigates the relationships of thinking styles with various student and teacher characteristics, both demographic (e.g., gender, age, birth-order, socioeconomic status) and situational (e.g., extracurricular activities and perceived learning or teaching environment). The second series of studies investigates the role of thinking styles in various aspects of student learning and development, including academic achievement, self-esteem, cognitive development, personality, and psychosocial development. The third series identifies the nature of the relationships of thinking styles with style constructs proposed by other theorists, including Biggs' (1978, 1992) learning approaches, Holland's (1973, 1994) career personality types and Torrance's (1988) modes of thinking. All of the studies have found significant results. The TSI-RII, like its two fore-runners, has good external validity, and thinking styles measured by the TSI-RII are capable of producing significant results, as hypothesized by scholars (Fan & Zhang, 2014). For instance, Zhang et al. (2013) have shown that students' preferred teaching methods are significantly associated with their thinking styles (e.g. student-focused teaching way and external style, $r = .45$, $p < .001$). To ensure both reliability and validity, I employed the TSI-RII in my study for the measurement of students' thinking styles.

It is supposed that students' thinking styles remain stable over a short period of time, for example, one term, particularly in a relatively constant environment (Richardson, 2013). Thus the participants in my study responded once to the Chinese version of the TSI-RII (Sternberg et al., 2007) at the beginning of my fieldwork, namely, at the beginning of the Autumn Term. The TSI-RII consists of 65 statements in total, with five statements corresponding to each thinking style. Examples include 1) 'When faced with a problem, I use my own ideas and strategies to solve it' (i.e. legislative style); and 2) 'I like to figure out how to solve a problem following certain rules' (i.e. executive style). Due to the protection of intellectual property rights, it is not possible to show the whole questionnaire. However, one statement for each thinking style is shown in the Appendix A. After each statement, there is a 7-point Likert-type scale for self-rating, ranging from 1 to 7, with 1 indicating that the description does not at all represent the way one normally behaves or carries out tasks, and 7 indicating that the statement characterizes extremely well how one tends to behave (Zhang et al., 2013). Participants were

asked to circle one number after each item, to indicate which best characterized their behaviours. Subsequently, I collected the completed questionnaires to calculate students' scores with respect to the 13 thinking styles. The responses to each set of five items were then averaged to represent a tendency to use the corresponding thinking style. Every participant therefore was labelled with 13 scores representing his/her tendencies with regard to each of the 13 thinking styles.

3.5 Collection of data concerning talk in classroom dialogue

I employed systematic observation together with the assistance of video to collect data relating to classroom talk. Live observation, with a researcher sitting in the classroom taking records of what happens between teachers and students, is a method that is frequently used to assess classroom dialogue (Croll, 1986). The popularity of observation is because it permits direct access to naturally occurring classroom events (Muijs, 2004), which allow the researcher to take objective account of students' participation, and, to some extent, reduce subjective inference. This advantage is particularly obvious when systematic observation is employed. Systematic observation "allocates observed talk to a set of previously specified categories", and then the "quantitative results can be subjected to statistical analysis" (Mercer, 2010, p. 3). By transforming dialogue into statistical data, a more objective account of how classroom dialogue relates to other factors can be produced (Howe & Abedin, 2013; Nystrand et al., 2003).

Apart from observation, videotapes often play an assistant role in recording students' contributions to classroom dialogue (Howe & Abedin, 2013). With a large class, the researcher may find it difficult to keep track of the performance of every individual student, and there is a potential risk of omitting important information during live observation (Muijs, 2004). Videotape is helpful in reviewing individuals' participation, and assists in confirming observations, figuring out unintelligible events, and revising previous recordings (Gibson, 2010; Jewitt, 2012). Videotape also permits two or more observers to code the same classroom events. This is for the purpose of estimating inter-coder reliability and is viewed as a good way to ensure the reliability of a coding scheme (Hartas, 2010b). Therefore I decided to use systematic observation and video-recording to measure how students made verbal contributions in classroom dialogue.

3.5.1 Coding instrument

In conducting systematic observation, a critical procedure is to "construct a set of categories into which all relevant talk can be classified" (Mercer, 2010, p. 3). As Cornelius et al. (1990) note, the major problem associated with understanding the effectiveness of classroom dialogue is that studies have examined this issue using different methods. Further, most scholars have employed a qualitative approach and have used codes that emerge from specific scripts. Given the lack of universally agreed codes, this has made cross-study comparisons difficult. Therefore designing a coding instrument that is suitable for quantitative study and generalizable to other studies is greatly needed.

For my MPhil work, I designed a coding scheme that I used to record classroom talk. It consisted of two main parts, with one used to measure talking frequency and the other to measure talking quality. Talking frequency refers to the amount of time that a student contributes to or talks in classroom dialogue (Brophy & Good, 1970). This raises the issue of what specific behaviours should be counted as verbal participation. In Jones and Gerig (1994), several forms of verbal participation are differentiated as follows: raising hands to answer questions voluntarily, raising hands to initiate a comment or a question, calling out "a response without waiting to be called on by teachers" (p. 173), and being called on by teachers when not putting hands up or giving answers in turn. However, Altermatt, Jovanovic and Perry (1998) have combined the first two forms, and have produced three forms: students raising hands waiting to be called by teachers, students answering without waiting to be called, and students being called upon to answer questions when they do not volunteer to do this. The categorization in Burns and Myhill (2004) is similar to that of Altermatt et al. (1998), but uses different expressions, which include raising hands to answer questions, joining in collective answers, shouting out answers without being called and being called to answer questions when failing to raise hands. In order to clarify the specific forms of participation, I classified participation frequency according to two dimensions: whether or not a teacher initiated a dialogue, and whether or not students contributed when they showed an intention to talk in class. This yielded four forms of participation, which are illustrated in Table 3.1. When participants' behaviour fitted one of these four categories, it was counted as one instance of verbal participation in classroom dialogue, and marked in the grids under the corresponding categories.

Table 3.1 Forms of classroom participation that are included in my study

	Teacher initiates	**Teacher does not initiate**

Student shows intention to respond and contributes	**TISC**: Teacher initiates a dialogue (e.g. asks a question), students are allowed to respond (answer questions, make comments or ask questions) when they intend to participate (e.g. raise hands)	**TNISC**: Teacher does not initiate a dialogue (e.g. asks a question), but students contribute (e.g. call out an answer)
Student shows intention to respond, but does not contribute	**TISNC**: Teacher initiates a dialogue, students are not selected to respond (answer questions, make comments, or ask questions) when they intend to participate (e.g. raise hands)	**TNISNC**: Teacher does not initiate a dialogue (e.g. asks a question). Students show intention to participate (raise hands), but they are not allowed to contribute

As regards the quality of verbal participation, I evaluated both the 'standard level' and 'cognitive level' of talk. 'Standard level' refers to the accuracy of answers and consists of 'correct response', 'incomplete or partially correct response', and 'incorrect response' sub-categories. Accuracy usually aims to evaluate whether students have mastered the basic knowledge in the textbooks (Brophy & Good, 1970), and is particularly crucial for Chinese students and something that is highlighted by teachers (Fung & Howe, 2014). Thus it was necessary to evaluate the standard level of students' contributions. However, in the case of some responses, it was not possible to assess them against an absolute standard of correctness, especially when students' own views were expressed. Also, a correct answer is not necessarily of higher quality than a partially correct one (Chin, 2006), since they may be given in response to questions with differing levels of cognitive complexity (Marsha & Webb, 2012; Pontefract & Hardman, 2005). Furthermore, according to Mercer (2000), the function of dialogue should be to enable the co-construction of knowledge, and improve understanding and thinking through interaction. In line with this view, high-quality participation should embody students' thoughts and reasoning processes (Pontefract & Hardman, 2005). I thus considered 'cognitive level', which was coded as 'information statement' and 'reasoning'.

It was feasible to use this coding scheme to measure talk during systematic observation, and the data collected for my MPhil were particularly useful for quantitative analysis. The scheme's reliability and validity can be shown as follows: firstly, the inter-coder reliability between the tutor's and my own observation was good (.89) and the inconsistent points were fully discussed before reaching consensus. This indicates that verbal participation as measured by my instrument generally reliable. Secondly, the results of my study were compatible with those assessed through other coding tools (see e.g. Burns & Myhill, 2004; Nystrand et al., 2003).

I found that high attainers talked more and made a higher level of contributions during classroom dialogue than low attainers. This is also reported by other studies, for instance, those of Burns and Myhill (2004), Good et al. (1973), and Nystrand et al. (2003). This indicates that results attained through the coding scheme I designed are valid.

The coding scheme generally proved to be reliable and valid, yet I decided to polish it to make it more suitable for collecting data for my PhD work. During observation in everyday classrooms, dialogue moves quickly and it is necessary for coders to assign coding categories within a short space of time. Thus clear descriptions of each coding category are essential to optimise the reliability of a coding instrument. In my MPhil fieldwork, I found that descriptions for categories within the 'cognitive level' (i.e. information statement and reasoning) seemed to be overly general and insufficiently clear, and could therefore prove confusing. As a result, I clarified the descriptions within 'information statement' and 'reasoning', adding specific situations and examples.

Dialogue that merely replicates or reports others' voices or prior knowledge is at a lower cognitive level (Chin, 2006; Nystrand et al., 2003; Wells & Arauz, 2006). It usually only requires recitation to contribute this kind of dialogue, and it is given in answer to closed questions. Inclusion of this kind of dialogue is necessary, as a great number of studies have found that it is the one most commonly seen in normal class settings (Vande Veen & Van Oers, 2017; Nystrand et al., 2003). For instance, the study conducted by Nystrand and Gamoran (1991) included a large and diverse sample of eighth- and ninth- grade classrooms. They found that the vast proportion of the dialogue contributed by students involved recalling and displaying assigned information, that is, reporting on what was already known. In order to sort out the specific types of dialogue belonging to the low-level forms, I reviewed other scholars' classifications.

In Nystrand et al. (2003), dialogue at a lower cognitive level consists of a record of an ongoing event and recitation and report of old information. Wells and Arauz (2006) also refer to 'rote recall' or 'memory/prior knowledge', and report 'previous conversation' as being lower cognitive dialogue. In addition, they view dialogue based on personal experience as low level, including 'experience' (personal events happening in an individual's life), 'imagination' and 'opinion' (personal beliefs about a situation). In my modified instrument, I named the category indicating lower cognitive level 'assumed known information', and took the above two circumstances (i.e. prior knowledge and personal information) into consideration. Dialogue describing prior knowledge consists of standard-referenced knowledge, reports of facts, rule-governed answers, and replications of previous conversation; dialogue revealing personal

information involves experience, imagination and subjective opinion. The descriptions and examples of each category can be seen in Table 3.2.

As regards dialogue requiring a high level of cognition, Newmann (1988) judges that dialogue of this type takes place when questions cannot be answered through the routine application of prior knowledge. Pontefract and Hardman (2005) code high-level cognitive dialogue as 'reasoning/thought', and this was how I proceeded in my MPhil work. Chin (2006) has designed a much more specific coding instrument, comprising categories such as comparing, evaluating, hypothesizing, explaining, interpreting and drawing conclusions to represent high-level cognitive dialogue. Chin's (2006) categories are explicit, and helpful in understanding the process of reasoning. Yet the categories have been designed to be used in qualitative analysis, and were far too specific for systematic observation. Nystrand et al. (2003) refer to four circumstances when distinguishing high-level cognitive dialogue: generalization, analysis, speculation and uptake. Generalization displays inductive reasoning and development of ideas; analysis reveals deductive reasoning, breaking down concepts, ideas and arguments; speculation considers possibilities, going beyond the information given; uptake refers to dialogue that incorporates a previous answer and then builds on or extends it. These four divisions have been proved to be reliable, having been coded by more than two researchers with high inter-coding reliability. Also, these four divisions have been approved and used in several other studies, such as that of Wells and Arauz (2006).

I applied the four categories described in Nystrand et al. (2003) to my coding instrument, feeling that they captured important distinctions in the evaluation of students' contributions. Firstly, generalizations display inductive reasoning and building up ideas. It was necessary to consider generalization as a high level form of dialogue in my study. In Chinese high school education, learning subject matter and knowledge is rather difficult and complicated; students are required to master numerous methods and skills to solve problems. Generalization helps them to sort out course content and summarize knowledge, which is essential to thinking and learning. Generalization involves a process of connecting different knowledge, comparing similarities and differences, evaluation and summarization. Thus it certainly shows a high level of cognition when someone contributes to a generalized type of dialogue. As regards analysis, it displays deductive reasoning and breaking down concepts, ideas and arguments. As referred to in Section 2.2.2, the ability to analyse problems is emphasized by the Chinese education authority. Mathematics and science are particularly demanding with regard to analysing ability. When talking about analysing problems, students not only have to present a conclusion or an answer, but they also have to give reasons and illustrate the process of reaching a conclusion.

I thus considered analysis to be a form of dialogue showing a high level of cognition. The third form, speculation, usually describes a type of dialogue that predicts what will happen next based on fundamental theories and facts (Wells & Arauz, 2006). It requires students to have a solid mastery of existing theories and facts, based on which they understand observed patterns and then consider possibilities for the future. The process of speculation requires a high level of cognition, and thus was included in my study. In terms of uptake, it is important not only for its recognition of students' previous contributions, but also for its essential role in facilitating negotiations of understanding (Nystrand et al, 2003). Uptake requires conversers to listen carefully to previous dialogue, reflect critically, produce their own thoughts and then respond to each other. This process demonstrates a high cognitive level, which is helpful for thinking and reasoning. Moreover, by building on what others have expressed and by establishing links among speakers, uptake "acts to promote coherence within discourse" (p. 146). Thus I included uptake as a form of dialogue showing a high level of cognition.

Moreover, I believed that subcategories of the coding scheme were necessary, and the four types of reasoning were included in the study. There are two main reasons. Firstly, besides testing the moderation model, I was also interested in building a more accurate image of how Chinese students talk in classrooms, and the subcategories enabled me to address this issues. Also, I aimed to investigate the relationship between thinking styles and participation in classroom dialogue, and this was listed as one of the research questions (see Research question one: *How are thinking styles correlated with participation in classroom dialogue? Can the significant relationships found in my MPhil work be applied to students aged 16 and above?*). By using the subcategories, a comprehensive understanding of how each thinking style correlates with diverse types of dialogue would be possible. In particular, generalization, analysis, speculation and up-take are all essential aspects of high-quality dialogue. Including these four subcategories would maximize the chances of discovering relationships between high-quality talk and individual styles. Secondly, it was feasible to collect these data and then subject them to correlational analyses. In my MPhil work, I collected data for only two weeks, and the amount of data was sufficient for correlational and regression analyses. With three months devoted to observation in my PhD work, it was highly likely that the data collected for each sub-category would be sufficient to address my research questions. The descriptions and examples of each category are illustrated in Table 3.2. The revised overall coding instrument for observing verbal participation in classroom dialogue is summarized in Appendix B.

In order to test whether the revised coding instrument was feasible for use, I piloted it in each of three lessons, mathematics, English and physics[3], respectively, in one of the selected schools. I asked a tutor from the school to observe students' participation together with me. This was for the purpose of estimating inter-coder reliability and was viewed as a good way to ensure the reliability of a coding scheme (Hartas, 2010b). Inter-coder reliability refers to the consistency with which two (or more) coders evaluate the same data using the same scoring criteria (Bailey, 1998). The consistency between two coders is most commonly determined by Kappa statistic, (Hayes & Hatch, 1999), which is calculated through the following formula: Kappa= $(p_o - p_e)/ (1- p_e)$[4]. The calculation is based on the difference between how much agreement is actually present ("observed" agreement) compared to how much agreement would be expected to be present by chance alone ("expected" agreement) (Cohen, 1960).

Before observation, the tutor familiarized herself with the coding instrument, including the definition of each category and examples. In the cases that she found unclear, I explained carefully until she fully understood. We sat at the back of the classroom and coded classroom dialogue live using the categories listed in the coding instrument. We both agreed that it was manageable to code students' classroom participation using the revised coding instrument. According to Hartas (2010b), observation is reliable when the inter-coder index reaches .65. Inter-coder reliability between the tutor's and my own observation was much higher (.81), and the inconsistent points were fully discussed before reaching a consensus. There were two main differences between us. One was confusion over the distinction between speculation and personal information, as one aspect of personal information was imagination. These two categories both concerned possibilities that might happen in the future. So I supplemented the descriptions of these categories and clarified that speculation should be seen as the kind of dialogue having theoretical or factual grounds, while personal information did not have to. The other source of difference was about which kinds of talk should be coded as uptake. The tutor regarded the kind of talk that merely repeated previous talk as up-take, while I disagreed, as students who contributed this kind of talk did not build up or construct knowledge. In order to eliminating misunderstanding, I thus refined the definition of up-take to mean that extension of talk should make a constructive supplement based on previous talk, rather than simply be a repetition of previous speaking. After these changes, the coding scheme was expected to be a reliable tool for measuring students' participation in classroom dialogue.

[3] The reasons for choosing these three subjects were shown as follows in Section 3.5.2.

[4] P_e stands for expected agreement and p_o stands for observed agreement.

Table 3.2 Coding categories for qualifying verbal contributions in classroom dialogue (Developed from Chin, 2006; Nystrand et al., 2003; Wells & Arauz, 2006)

Category	Sub-category	Specific situations	Descriptions	Examples
Assumed known information (low cognitive demand)	Prior knowledge	Standard-referenced knowledge	Answers that can be judged right or wrong with reference to textbooks or knowledge that teachers have taught before.	The textbook said in one part, 'put forward' has a similar meaning to 'suggest'.
		Fact	Information of a public kind which the student(s) are expected to know and be able to remember.	The capital city of China is Beijing
		Rule-governed answer	Culturally recognized explanations and solutions to a problem of an algorithmic kind, as in arithmetic, which the student(s) are expected to know or be able to compute.	You should stop the car when a red traffic light appears.
		Report of previous conversation	Narrations or descriptions of previous contributions made by other students or teachers	Tom just said that the answer to this question was 59.
	Personal information	Experience	Events in the speaker's life that are not assumed to be known to other participants.	I worked hard for one year and finally won a first prize.
		Imagination	A personal response of an imaginative kind to a situation or work of art, etc.	I imagine that she must have consulted many people before she figured out the issue.
		Subjective opinion	What the speaker personally believes about a topic or situation of personal concern.	I personally dislike this new building.
Reasoning (high cognitive demand)	Generalization	Summarize	The process of formulating general concepts by reasoning from detailed facts. It involves inductive reasoning and the development of ideas. It aims to respond to questions requiring beyond statement of information.	I compared and found that…both Articles A and B investigated the relationships between two variables.
		Compare		
		Connect		
	Analysis	Exemplify	Abstract separation of a whole into its constituent parts in order to study the parts and their relations. It involves deductive reasoning, and makes knowledge explicit and easy to understand.	I don't think that's the best because some people might- if they pick all their friends they...they might get too crazy and then they won't get any work done.
		Evaluate		
		Clarify/Explain		
	Speculation		Consideration of possibilities, going beyond current state of knowledge but having theoretical or factual grounds.	His brother might be able to offer Tom some funding, since his brother just made a successful investment.
	Up-take	Challenge previous talk	The issue here concerns the way in which the previous response by somebody else is taken up. Uptake can be realized in a comment that explicitly recognizes the previous response and builds on it in some way; or it can be realized in a question that asks the previous responder to extend what s/he has said. Extension of talk makes a constructive supplement based on previous talk, rather than simply a repetition of previous speaking.	Tom said that Boo has adopted the kids. But how does he know about the relationship between Boo Radley and the kids?
		Extend previous talk		
		Clarify previous talk		

3.5.2 Procedures for lesson observation

There are two terms in high school education in mainland China, one being the Autumn Term lasting from September to January the following year, and the other one being the Spring Term lasting from March to July. As the Autumn term fitted the time suggested for fieldwork by our Faculty, I started conducting my observation of participation in classroom dialogue during September 2015 and finished in March 2016. I observed mathematics, physics and English lessons. My focus on the three subjects was for two main reasons. Firstly, they are emphasized by the Chinese government, especially mathematics and English (Ministry of Education of the People's Republic of China, 2010). Moreover, the examination of mathematics and English is mandatory for all high school students, regardless of whether the focus is science or liberal art. Scores in these subjects are viewed as essential references when students apply for universities and jobs. Secondly, these three subjects are also studied by students in many other countries, such as the UK and the US, and have been widely investigated by scholars worldwide. Mathematics and science subjects are most frequently selected for study when scholars are aiming to investigate whether classroom dialogue is beneficial for reasoning and learning (see Howe & Abedin, 2013). The study of these subjects enables comparisons to be made between diverse social contexts.

In every class, different teachers were arranged for mathematics, physics, and English subjects. There was no overlap across the classes, except that the two classes in No 3 Middle School shared one physics teacher and one English teacher. Thus 16 teachers were involved in total (1 teacher per subject $\times 3$ subjects $\times 6$ classes – 2 shared teachers). I achieved the agreement of all teachers before I observed their lessons. For each class selected, I observed on two consecutive days each month. In my selected schools, since mathematics, physics and English were viewed as superior subjects, there was a daily lesson for each of them in every class. Thus during my visit, I was able to observe one lesson in mathematics, physics and English respectively every day, resulting in about 108 observations in total (3 lessons each day of observation $\times 2$ days each month $\times 3$ months $\times 6$ classes). Each observation lasted for 40 minutes, which was the length of one lesson in the selected schools.

Students had fixed seats in the classroom, which were arranged in rows and columns. Before I conducted my observation, I asked for a seating map, which had students' names and their seats. The seating map helped me identify students from the back of the classroom where my seat was located during observation. During observation, I used each student's seat to code them, not his/her real name, for instance, a student sitting in the first column and the fifth row was coded as 1.5. This increased the likelihood of anonymity and thus protected participants' confidentiality. However, due to the requirements of the research purpose, it was necessary to know who the students were to tie the

observations up with thinking styles and learning outcomes. Referring to the seating map made it possible to know real names and addressed this issue. Moreover, I was given an outline of the course content the day before I conducted the observation. This allowed me to familiarize myself with the material and react quickly when choosing which category to mark during live observation. Course content in mathematics included quadratic functions, conic curves, and derivatives; the main content in English courses was the use of non-predicate verbs, past participles and new words and sentences to describe American politics; the course content in physics covered damping vibration and gravity. There was a typical pattern for all of the classes: teachers started a course by reviewing the knowledge taught before, which usually lasted about five to ten minutes; then new knowledge and theories were delivered, followed by exercises that used the theories. Almost all of the lessons followed this pattern. Notably, I had previously received the same kind of high school education, and thus a course outline was sufficient for me to recall the knowledge and content.

During observation, I employed the coding instrument that I had designed, as described above (see Appendix B), and whenever a participant's behaviour fitted one of the categories, it would be marked once on the grids under the corresponding category after the student's ID. It is possible that after a student had answered a question, commented on a topic or initiated a dialogue, he/she would continue to be asked a further question or about another topic, or would initiate another dialogue. In this case, the student would be counted as having contributed twice, and corresponding categories would be marked twice. However, within each instance of participation, a single student was likely to have provided, for example, multiple correct answers and analyses. In the case of multiple correct answers and analyses given for a problem, I marked only one instance of 'correct' behaviour and one instance of 'analysis'. I marked the instances of students' contributions according to the strokes of the Chinese character '正'. For instances, when a student answered a question asked by the teacher for the first time, I marked '一' under the corresponding category, TISC; when the student continued to answer a question for the second time, I marked '丨' below the first '一' under the category, TISC. Five instances of contribution under a certain category would make a character '正'. I just needed to count how many characters there were in the grid under a category, and then multiply by five, which would give the total number of contributions a student had made. This way of marking saved space in the table, and made it easy to count and calculate each student's contributions. The coding instrument and the coding trick were tested in my pilot study. They worked well and allowed me to keep up with the pace of each lesson. In my selected schools, students' classroom participation, talk in particular, was not used to evaluate learning outcomes, allowing students to contribute at will. Thus vocal students in this study were largely, if not entirely, in these categories by choice.

Two video recorders were placed in the classroom to record how students behaved in class, with one high up in a front corner and the other one high up in a back corner. These two videos provided a clear view of the whole class, and students' behaviour generally could be captured and observed from the videotapes. The three selected schools had equipped every class with two videos with the purpose of monitoring teaching and learning, and students were used to this equipment. Thus the videotape did not interfere substantially with the normal lessons. I achieved permission from these schools for videoing lessons using their existing equipment. It should be noted that videotapes were not allowed to be copied and could only be seen in these schools. After coding in class, I looked at the videotapes immediately after the lessons to check whether any critical information had been missed. In classroom settings, talk may be very lively and students may speak simultaneously. This would make it difficult for researchers to count each student's contributions and to distinguish between who is talking and who is not. In my pilot study, I observed lessons and found that this situation occurred less than might be expected. I also consulted the school teachers and they reported that the lively situation when students talked simultaneously was not commonly seen. Lessons usually progressed in an orderly manner led by the teacher, and students were encouraged to participate by providing answers to questions initiated by the teacher. Talking simultaneously and loudly was viewed as behaviour that might result in disruption in class and thus was not welcomed. However, when it happened, I could observe students' contributions with the assistance of the video recording. Being rare, it was manageable. It was found during the observation that, although students in different classes were taught by different teachers, teachers' personal characteristics seemed to have little influence on students' classroom participation and learning. This is because they taught according to the same syllabus, used similar or even the same teaching methods, and were monitored to ensure progress was maintained at the same pace.

In formal data collection, I did not ask a fellow researcher or a tutor to recode observations of classroom dialogue. There were several reasons for this decision. Firstly, the coding instrument used to measure students' participation had been developed from the one in my MPhil study. The categories used to code both participation frequency and the standard level of quality were the same as those in my MPhil work. The categories used to code the cognitive level of participation have been decomposed from those in my MPhil work. Given that the coding instrument in my MPhil had proved to be reliable and valid, it was likely that participation data measured using its revised version would be of good quality. Secondly, it is generally agreed that inter-coder reliability is best tested through a pilot study prior to the full study (Hayes & Hatch, 1999). According to Gwet (2001), inter-coder reliability should be "improved at the planning stage, before data collection, in order to ensure the validity of the findings" (p. 234). I had tested the coding instrument in my pilot study and the inter-coder reliability was good,

which is a strong indication that the participation data coded by the instrument would be reliable. Thirdly, in practice, it was difficult to attain approval from the principals and teachers to bring another person with me into their classrooms to help with observation. As that was the case, videotapes were the only source from which to code students' classroom participation if inter-coder reliability needed to be assessed. However, videotapes cannot take the place of live observation and fully restore real situations, which is probably the reason that video is usually employed as a supplementary tool. It would have been less reliable if I had asked another person to code students' participation behaviours based on videos. The inter-coder reliability resulting would have been of less value. Therefore, in consideration of the above reasons, I decided not to conduct peer coding.

3.6 Collection of data concerning attentive silence

As noted above, self-report questionnaires are useful for eliciting individuals' attitudes and views about social situations (Rea & Parker, 1997). These data cannot usually be observed easily (Hartas, 2010a). With reference to my study, when students remained silent, it was nearly impossible to tell from observing whether or not they were paying attention to course content, taking advantage of classroom dialogue to learn, and experiencing satisfactory learning achievement. A self-report questionnaire is capable of filling in such a gap. Moreover, the data collected through questionnaires can be transformed into numerical forms, which can then be subjected to quantitative analysis. Although it is claimed that people may only report what they want to be known or may conceal certain things in order to appeal to researchers' fancy (Muijs, 2004), a well-designed questionnaire is "capable of producing valid and meaningful results" (Hartas, 2010a, p. 258). Thus I used questionnaires to collect data concerning attentive silence.

Very few scholars have viewed silence as a form of participation in classroom dialogue, and there was a scarcity of ready-made questionnaires that could be applied directly to my study. Thus designing a questionnaire for the measurement of attentive silence was a key stage. According to Hartas (2010a), when developing an instrument, "the content of the questions should be developed in such a way as to reflect/capture the research aims" (p. 265). This is probably the most important criterion for evaluating the quality of a questionnaire. Apart from research aims, reliability and validity should also be considered. Construct validity reflects the "conceptual coherence between a construct" (Hartas, 2010b, p. 75). Internal consistency determines whether items reflect the same construct that they are supposed to measure (Field, 2009). A questionnaire is perceived to be reliable when Cronbach's alpha reaches .60 (Hartas, 2010b). In addition, questions should be concrete and described in such a way that respondents can understand them.

In my study, the reason for employing a questionnaire was to measure how students engaged in classroom dialogue through attentive silence/listening, so that this could be related to thinking style and thus it would be possible to investigate whether thinking style affects how much knowledge a student gained by listening. As reviewed in Section 2.2.1, a great many studies have classified participation in classroom dialogue into participation frequency and quality. As attentive silence is viewed as a form of participation, it should also be approached from these two perspectives (i.e. frequency and quality). The frequency and quality of listening therefore acted as two main constructs when I designed a questionnaire.

Based on these two constructs, I formulated a total of 15 items. The first five items (1-5) related to the first construct - frequency. Teachers' instructions, students' responses to teachers' questions and students' discussion are the three main circumstances in which a student is supposed to listen carefully. Thus three items were devised to reveal students' performance in these three circumstances. Taking notes during class is also often viewed as a sign of paying close attention to course content, while day-dreaming is a sign of failing to listen carefully in class (Schultz, 2003, 2009). Considering these two circumstances is arguably helpful in distinguishing whether students make good use of classroom dialogue, even if they rarely talk, and hence they were represented in the final two items.

The next ten items (6-15) were related to the second construct - quality. Items 6-10 aimed to measure listening quality from the perspective of learning experience. Whether or not a student feels comfortable when he/she employs a particular learning method is considered to be an essential criterion for evaluating learning experiences (Dallimore et al., 2010). I thus used degree of comfort to test how students felt about talking and remaining silent in particular situations. Items 11-15 were designed in order to measure listening quality using students' perceptions of achievement. It has been found that the quality of learning experience is closely correlated with students' perceptions of achievement (Cashin & Downey, 1999; Ryan & Harrison, 1995). This suggests that listening in classroom dialogue will be more effective, in other words, of higher quality, when students perceive they have attained good learning outcomes. Memorization of course content, solving problems, reasoning critically, creativity and applying knowledge to novel situations are five important aspects that are commonly used to evaluate students' learning performance (see James & Brown, 2005). Thus I devised five items to discover how students evaluated their learning effects after listening to classroom dialogue.

After each item, there was a 5-point Likert scale, which offered five responses, ranging from 1 to 5, with 1 indicating that students never performed in the way described in the statement and 5 indicating that students always performed in that way. For the first five items, the greater the number that was ticked by a student, the more time he /she spent on listening during classroom dialogue; for

the remaining items, a higher number ticked suggested that the student made better use of classroom dialogue through listening. The 15 items are illustrated as follows. The final questionnaire for measuring listening is shown in Appendix C.

1) I listen to the teacher's instructions.
2) I listen to other students' talk when they answer questions.
3) I listen to other students' discussion.
4) I do not day-dream during class.
5) I take notes while I am listening in class.
6) In the class, I feel uncomfortable when I answer questions.
7) In the class, I feel uncomfortable when I discuss with other students publicly.
8) In the class, I feel uncomfortable when I ask questions.
9) In the class, I feel comfortable when I remain silent but listen to other students' talk.
10) In the class, I feel comfortable when I remain silent but listen to the teacher's instructions.
11) I memorize knowledge better when I remain attentively silent in classroom dialogue.
12) I think more critically when I remain attentively silent in classroom dialogue.
13) I solve problems better when I remain attentively silent in classroom dialogue.
14) I come up with more creative ideas when I remain attentively silent in classroom dialogue.
15) I apply existing knowledge to solve novel problems better when I remain attentively silent in classroom dialogue.

I tested the questionnaire with 75 students from No. 2 middle school in Gongguan, which was one of the selected schools for formal fieldwork. Piloting plays a key role in questionnaire construction, as it offers an opportunity to identify problems and refine items (Hartas, 2010a). It is generally agreed that the minimum number of pilot participants should be five times that of the items in the questionnaire. There are 15 items in my questionnaire, and thus I chose 75 pilot participants. Construct validity was tested by conducting an exploratory factor analysis on the pilot data, as this is useful in identifying clusters of highly correlated variables and can testify whether the designed items are capable of reflecting the main conceptual constructs (Field, 2009; Kim & Mueller, 1981). I engaged a principal-axis factor analysis with oblique rotation[5] to illustrate the inner-construct of the 15 items. The output showed that the Kaiser-Meyer-Olkin (KMO) value for the variables was .69 and Bartlett's test of

[5] Principal components analysis is simple but effective in determining factors that explain all the variance, including the error variance, in any particular correlation matrix (Field, 2009). Oblique rotation often results in higher eigenvalues and is advantageous in producing factors with meaningful explanations (Kim & Mueller, 1981).

sphericity showed that the significance level was well below .01[6]. This indicated that the factors extracted were useful in data reduction and capable of presenting the inter-construct of the 15 items. Furthermore, as seen in Table 3.3, I obtained a two-factor model, with items 1-5 loading on the first factor and items 6-15 loading on the second factor. This clustering strongly supported the design of my questionnaire with regard to the division between the frequency and quality of listening. Internal consistency is another element that is often taken into consideration when researchers test the quality of a questionnaire. I computed Cronbach's alphas to test whether the questionnaire had good reliability. Statistical analyses reported that the Cronbach's alphas for the participation frequency and participation quality were .91 and .87 respectively. The high values of alphas indicated that the questionnaire was reliable. To summarize, the questionnaire designed to measure listening in classroom dialogue was reliable and valid.

[6] (KMO) is a statistic used to predict whether the factors extracted are able to present the inter-construct of variables. Values of KMO above .50 indicate that the factors are useful (.50~ .60= weak; .60~ .70 = moderate; .70~ .90= good; > .90= excellent), while KMO lower than .50 is not acceptable. Bartlett's test of sphericity indicates the suitability of data for structure detection (Hartas, 2010c).

Table 3.3 Factor loadings for the Oblique-Rotated Factor-Analysis Models (*N*=75)

Items	Factor 1	Factor 2
1) I listen to the teacher's instructions	-0.09	**0.89**
2) I listen to other students' talk when they answer questions	-0.04	**0.87**
3) I listen to other students' discussion	-0.02	**0.91**
4)I do not day-dream during class	0.06	**0.82**
5)I take notes while I am listening in class	0.06	**0.76**
6) In the class, I feel uncomfortable when I answer questions	**0.54**	-0.30
7) In the class, I feel uncomfortable when I discuss with other students publicly	**0.56**	-0.19
8) In the class, I feel uncomfortable when I ask questions	**0.75**	-0.21
9) In the class, I feel comfortable when I remain silent but listen to other students' talk	**0.62**	0.11
10) In the class, I feel comfortable when I remain silent but listen to the teacher's instructions	**0.71**	0.14
11) I memorize knowledge better when I remain attentively silent in classroom dialogue	**0.73**	0.03
12) I think more critically when I remain attentively silent in classroom dialogue	**0.75**	0.22
13) I solve problems better when I remain attentively silent in classroom dialogue	**0.78**	0.13
14) I come up with more creative ideas when I remain attentively silent in classroom dialogue	**0.51**	0.07
15) I apply existing knowledge to solve novel problems better when I remain attentively silent in classroom dialogue	**0.45**	-0.14

Note: % var. = % of Variance, C. var.= Cumulative variance. The dominant styles within each factor were bolded.

The final questionnaire that was produced after piloting and modification is shown in Appendix C. In formal fieldwork, I asked the students in the corresponding classes to fill in the questionnaire once at the end of the Autumn Term. Notably, in the formal questionnaire, I asked students to fill in their classes and gender, but without asking for their names. I collected the completed questionnaires one by one and marked each of the questionnaires with the student's seating number, as described in Section 3.5.1; for instance, a student sitting in the first column and the fifth row was marked as 1.5 on the cover page of the corresponding questionnaire. This aimed to protect students' confidentiality. Students were aware that I would code their questionnaires later on, but would keep the coding confidential and not report to their parents or teachers. This was designed to make students more likely to report the real situation.

3.7 Collection of data concerning learning outcomes

3.7.1 Collection of data concerning academic achievement

There is an examination at the end of each term for the high schools that I selected for my study, namely, the final-term examination. It usually incorporates various types of test question, including multiple-choice questions and short essay questions. The examination is usually criterion-referenced, and aims to test whether students have mastered the learning content taught during that term of study. One example from the English examination paper is as follows,

What else did you do _____ sending e-mails?

---I watched a TV series on CCTV-1.

A. besides B. except C. except for D. except that

This multiple-choice question examined whether students had mastered the grammar introduced in the textbook. Students' abilities in analysing and solving problems are tested in the examination. One example was copied from the English examination paper, as follows.

From the report we can infer that Zhang Yan probably _____.

A. is not sure of his success in the coming exam

B. does a very good job in his studies.

C. will not be chosen by Peking University.

D. does not show much interest in Peking University.

This type of question was called reading comprehension. After reading a short article of about 300 words, students were asked to answer questions based on the article. The word 'infer' in the question was an indication that students' ability to analyse, reason and draw implications was being tested. The final-term examination results were a good reflection of the learning outcomes that had been produced through participation in class during a certain period of time. All participants taking the examinations used the same examination papers, which allowed comparison between schools and classes. For each participant, I collected his/her scores in mathematics, physics and English produced by the final-term examination, which was used to represent his/her academic achievement in the corresponding subject.

It is noticeable that some scholars have used not only the academic results that students achieved after classroom participation, but also those achieved before, which has allowed them to identify learning gains, for instance, the work of Brown and Palincsar (1989), and that of Fung and Howe

(2014). The literature reviewed in Section 2.5.1.3 suggests that previous academic achievement may have an effect on classroom participation. However, I only assessed students' achievement on the basis of the final-term examination following their classroom participation, but did not ask for their scores before. This was because the students who constituted my research sample had just progressed through the division between scientific and liberal approaches. They were studying new courses from the second year, which was the time I conducted my fieldwork. The students who had chosen to focus on science would no longer be studying courses relating to liberal arts, and the scores achieved in the first year had little relevance to their second- and third- year learning. There were certain instances when students whose scores had been low in the first year turned out to be good in the second year, as they were then clear about their learning path following the scientific-liberal division. Thus considering their previous academic scores, namely, those achieved in the first year, were less necessary in my study. Moreover, it was almost impossible to get their previous academic scores, as the participants were in different classes in the first school year and formed new classes from the second school year. The participants' previous scores were needed to pick out one by one, if their prior achievement needed to be assessed. Given a large number of students involved in my study, it would take ages to obtain their previous scores and the schools would not do it.

3.7.2 Collection of data concerning cognitive abilities

There are two recognized instruments that have been designed in order to assess the analytical, creative and practical abilities delineated from the Sternberg's Triachic Theory. One is called the Sternberg Triachic Ability Test (STAT) designed by Sternberg (1993), and the other one is the Self-Rated Ability Scale (SRA scale) proposed by Zhang (1996). I employed the STAT (Sternberg, 1993) to assess the analytical, creative and practical abilities proposed in Sternberg's (1985) Triarchic Theory. There were three main reasons for using the STAT. Firstly, it has been used in various cultures, such as Finland, the United States and Hong Kong, and has proved to be reliable and valid (e.g. Sternberg, 1999; Sternberg & Grigorenko, 2007). Secondly, it is the one of Sternberg's instrument that has been used when scholars have previously investigated the relationship between thinking style and abilities (see Zhang, 2004, 2010). I considered I would be more convincing if I used the same tool as previous studies had and based my assumptions on their results. Thirdly, in contrast to the STAT, the instrument designed by Zhang (1996) relies on students' self-report. This type of measurement is easily affected by students' personal factors and may be subjective in accounting for students' ability. Students' self-rating has been found to be affected by their self-esteem (Felson, 1981; Wells & Sweeney, 1986). It is possible that two students with the same level of cognitive ability may self-rate themselves as different,

as one student may have a higher level of self-esteem than the other. In order to maintain the objective and fair evaluation of cognitive ability, Zhang's instrument was less suitable and I thus employed the STAT instrument designed by Sternberg.

The STAT is a performance test, in which Level H is designed for students aged 16 and above. There are both Chinese and English versions. The STAT consists of both a multiple-choice test and an essay test to measure abilities, yet most studies employ the multiple-choice test only since the essay test cannot be graded objectively (see e.g. Sternberg, Castejón, Prieto, Hautamäki, & Grigorenko, 2001; Zhang, 2004). I also used the multiple-choice test only, which consists of 36 items, with 12 measuring each ability. In order to offer greater opportunities for students to show their abilities (Sternberg, 1999), Sternberg measures each ability in relation to three domains – verbal, quantitative and figural. This yields nine subscales (three abilities × three domains): analytical-verbal, analytical-quantitative, analytical-figural, creative-verbal, creative-quantitative, creative-figural, practical-verbal, practical-quantitative, and practical-figural.

Testing of each aspect of intelligence is done through three modes of presentation of problems: verbal, quantitative, and figural. Thus, analytical intelligence is measured through tasks relating to the application of meta-components, performance components and knowledge-acquisition components to conventional verbal, quantitative and figural problems requiring analysis and evaluation. Creative intelligence is evaluated by means of problems whose solutions require 'insight' processes for verbal, quantitative and figural contents. Practical intelligence is measured by applying these components to verbal, quantitative and figural problems that relate directly to everyday life. Examples of the STAT are illustrated in Appendix D.

This assessment tool is still at an experimental stage, but it has been used in a variety of cultural contexts, including the United States (Sternberg et al., 2001), Finland (Hautamäki, Arinen, Hautamäki, & Scheinin, 1998), Hong Kong (Zhang, 2004, 2010) and Spain (García, 1997). The STAT has been proved to have satisfactory construct validity. For instance, Sternberg et al. (2001) conducted a hierarchical confirmatory factor analysis to examine the structure of the Triarchic Theory of Intelligence, and the model's fit turned out to be generally good. Moreover, studies have reported that the STAT generally has satisfactory internal consistency. As reviewed by Zhang (2010), the overall Cronbach's alphas in all social contexts are above .60. It is noticeable that, in a recent study, Zhang (2010) has used the Chinese version of STAT to collect data from secondary school students in Hong Kong. The Cronbach's alphas were .67, .70 and .36 for the analytical, creative and practical abilities respectively. The alpha for the practical ability was below .60 and thus did not qualify for use in subsequent analyses. This may due to the fact that Zhang focused on secondary school students. Secondary schools in Hong Kong generally pay less attention to connections between knowledge and

real life (Cheung & Yip, 2003). The students there have limited access to practice and may therefore have a less mature understanding of issues in practice, and thus may become confused when they are tested with practical questions.

In my study, the measurement of cognitive ability was conducted once at the end of the Autumn term. The STAT is quite long and complicated, requiring participants to answer it carefully. I obtained assistance from the principals and teachers in the schools. They organized students to fill in the STAT during a particular period of time. This ensured that the students were focused on the test, and not distracted by other things. Also, with the teachers standing by, there was no chance of the students copying from each other. It generally took the students one hour to finish answering questions in the STAT and then I collected their test papers for grading. The STAT mark that each student achieved was capable of reflecting his/her real level of cognitive ability. I intended to conduct the measurement twice when I designed the research: one at the beginning of the term and the other one at the end, which was expected to allow me to see the changes in students' abilities following their classroom participation. However, I found that it was not realistic in practice, as organizing students to take the test was time-consuming and required assistance from the school. Students had a heavy study load, and their time was precious, which made it hard for me to obtain agreement for the measurement to be conducted on two occasions. Further, almost all studies conducted by other scholars measure cognitive ability once (e.g. Sternberg, 1997; Zhang, 2010). Thus in my study, students' cognitive ability was also measured once at the end of the term.

3.8 Collecting the interview data

After collecting the data intended for quantitative analysis, I used semi-structured interviews to provide supplementary understanding of why students performed in that particular way in classroom dialogue, whether they saw this as related to their thinking styles, and how they benefited from learning in the particular way. An interview is "literally an *inter view*, an inter-change of views between two people conversing about a theme of mutual interest" (Kvale, 1996, p. 14). According to Hobson and Townsend (2010), interviews provide opportunities for researchers to discover things relating to detailed personal experiences that will not easily be found through observation. This is particularly advantageous in providing an in-depth understanding of particular findings. In studies related to silence, scholars have frequently employed interviews to understand students' behaviours in classroom dialogue. For instance, Schultz (2003) interviewed silent students to listen to their voices; Jones and Gerig (1994) used interviews to make sense of how silent students felt about participation and why they did not engage in discussion.

As summarized by Freebody (2003), there are three main types of interview: structured interview, unstructured interview and semi-structured interview. The semi-structured interview proceeds around a number of predetermined questions while, at the same time, giving the interviewer and interviewee the relative freedom to depart from the questions when necessary. It is probably the most commonly used method of interviewing because of its advantages in helping "ensure coverage of the researcher's agenda while also providing opportunities for interviewees to talk about what is significant to them" (Hobsion & Townsend, 2010, p.231). As regards my study, it was anticipated that the data collected through questionnaires would demonstrate general patterns with regard to the relationships. However, semi-structured interviews would be useful for exploring the mechanisms underlying such patterns. This is because interviews allow participants to reflect on their own learning experiences, which are not confined to the questions set by the researcher (Hobson & Townsend, 2010).

Interviews were conducted at the beginning of the next term after I had obtained results from preliminary quantitative analyses. In my research proposal, I planned to interview 18 students, with three selected from each class. One of the three students would have talked a great deal in class; the second would have been comparatively silent, and the third would have been in the middle. I conducted pilot interviews with three students selected from one class. I found that the interviewee whose contributions ranked in the middle was more likely to ascribe his classroom performance to environmental reasons, not to his personal characteristics (e.g. 'I do not talk because the teacher did not leave us enough time to think'). My research primarily aimed to examine whether students' individual characteristics affected how they involved in classroom dialogue and the corresponding results. With this being a theoretical drive, environmental factors were not my focus. Transcripts of the student who talked to a medium extent were less relevant to my research focus and contributed little to my research questions. Given the limitation of time, I decided to select only the students who were either talkative or silent for my formal interviews, while excluding those contributed to a medium extent. Future studies could take a wider variety of students into account when environmental factors were the focus of researchers. Thus, in my study, 12 interviewees were included in total (2 students per class $\times$ 6 classes). This method of selecting interviewees involved different representations of participants in the classroom, and was helpful for exploring a range of opinions (Gaskell, 2000). The interviews were conducted on a one-to-one basis involving a single interviewee each time. During interviewing, interviewees were encouraged to give specific examples to describe and reflect upon their learning experiences in classroom dialogue. Audio recording was used after receiving the interviewees' permission. With the assistance of the local educational authority, teachers had explained the purpose of my study to the students, why their participation was necessary, how the study would

be used, and how and to whom it would be reported. At the beginning of each interview, students were told that the interview would be kept confidential and be reported neither to parents nor their teachers. Thus students were generally free to give candid answers to interview questions.

The average length of each interview was 30 minutes. This was feasible because interviews played a supplementary role in answering the research questions, specifically revealing the relationships that could not be shown through quantitative analyses. I originally designed more interviewee questions, starting from open questions and then moving on to more specific ones. Yet this proposal was not approved during my first year viva primarily on the grounds of feasibility as a PhD study. Quantitative data collection and analysis played a dominant role throughout my whole work, while the interviews assisted the understanding of the relationship. Moreover, with 12 interviewees participating in my study, it was probably desirable to keep each interview short. Thus I eliminated redundant description and kept the interview questions straightforward, which gave prominence to the key issues, for example, I asked directly about the relevance of participation to individual characteristics and learning outcomes. This is a limitation of my study as it could result in quite leading questions. In the future, if time and funding allow, more open questions asking students what factors impact their decisions to contribute to dialogue could bring about more fruitful and interesting findings. Given the above reasons, three interview questions were kept as follows, with ten minutes allowed for each question. The questions were opening gambits in a semi-structured interview.
Introduction: I am Yu Song, a PhD student from the University of Cambridge. I would like to learn about your experience in class.

1. I noticed that you were quite silent in the class, why did you not talk? [For students relatively quiet]
I noticed that you talked a lot in the class, why did you participate actively? In other words, what impels you to talk? [For talkative students]
2. Do you find it is related to your personal characteristics?

    2.1 When students' answered 'yes', I asked a follow-up question: 'How did your personal characteristics influence your preference to be talkative or remain silent? Could you please give examples of your experience to explain this to me?

    2.2 If interviewees talked too much about some other personal characteristics without mentioning thinking styles, I asked another follow-up question: Do you find it is particularly related to your typical ways of thinking? [Depending on interviewees' responses, I might have needed to use specific examples to explain the definition of thinking style]

3. Did you find your silence prevented you from learning well? Or did it help you? Why? [For students relatively quiet]

Did you find talking in class helped your learning? Or did it hinder you? Could you please give examples of your experience to explain this to me? [For talkative students]

3.9 Ethical issues

Ethical guidelines developed by the British Educational Research Association (BERA, 2011), were followed precisely in the course of conducting my research. First and foremost, achieving informed consent from relevant people was essential. I obtained authorization and consent from the principals of the three selected schools. The principal of a school acts as a gatekeeper for students and their learning, and can ensure the research will not bring any risks to students' physical and mental health. I gave relevant students and teachers in the six classes information about "why their participation is necessary, how the study will be used and to whom it will be reported" (BERA, 2011, p. 5), so that they could have a better understanding of the objectives of my research. I also informed them about the research procedure. Participants needed to fill in the questionnaires for measuring thinking style and listening in classroom dialogue, take a cognitive test, and be observed in class. In particular, as video-recording was used during class observation and audio-recording was involved during the interviews, it was necessary to explain these two aspects to students explicitly (BERA, 2011). I assured students that the recorded videos and radios would only be used for this research, and not for commercial purposes. Also, their identities would not appear in my final report, which would protect students' confidentiality. Based on the information, students decided for themselves whether they were willing to be involved as participants. Since students aged 18 are already adults, they are capable of making their own judgements. I thus did not ask for the consent of the students' parents. Students were allowed to withdraw at any stage of my study if they wished.

Apart from achieving consent, anonymity and confidentiality are two other essential elements requiring consideration in order to protect participants (Lindsay, 2010). In my study, when students responded to questionnaires, complete anonymity was impossible as data concerning each individual's thinking style, participation and learning outcome were collected separately, and needed to be tied up subsequently so that I could analyse how a particular pattern of thinking styles affected the relationship between participation and learning outcomes. Nevertheless, reducing the likelihood of identification was necessary (Lindsay, 2010). For all the three questionnaires, I did not ask students to report their real names when they filled in the questionnaires. Instead, as noted earlier, I coded students with their seating numbers, which were applied when collecting the completed questionnaires (i.e. TSI-RII, questionnaire for attentive silence, and STAT). I had informed students before handing out

questionnaires that I would code their questionnaires and classroom participation with a number, because there was a need to examine relationships between the data collected separately. I assured them that only I knew the identity of the student to whom each coding number referred and I signed a contract to keep the information confidential. The details of seating number and student identity do not appear in my final report, thus protecting participants' confidentiality. Students would be more likely to report the real situations if the data were to be kept confidential, particularly from teachers and their parents.

3.10 Timetable

The following is a timetable which summarizes how and when all the instruments were administered, together with an illustration of how I conducted my fieldwork.

Time period	Procedures
May-Aug 2015	Contact and confirm schools; achieve informed consent from relevant students and the principal
	Pilot the questionnaire used to measure attentive silence/listening in classroom dialogue on 75 students.
	Pilot the coding scheme used to observe talking in classroom dialogue in three lessons; invite a tutor to code the lessons together with me; assess the inter-coder reliability and modify the inconsistent parts.
Early Sep 2015	Hand out a questionnaire, TSI-RII, and collect data on thinking styles
	Request seating maps of the six classes; request outline of course content for each of the observed lessons.
Mid Sep 2015 - Dec 2015	Observe classroom dialogue and field-code talk in classroom dialogue
	Refer to the videotape immediately after each day of observation, and add any missing information
Jan 2016	Hand out a questionnaire and collect data on attentive silence in classroom dialogue
	Measure the students' abilities with the STAT； mark the test paper and label each participant with scores for the corresponding ability.
	Ask for final-term scores from the principal
Feb 2016	Conduct a preliminary quantitative analysis
	Pilot and revise sample interview questions based on the results of the preliminary quantitative analysis

Mar 2016	Conduct and record semi-structured interviews
	Transcribe the audiotaped interviews and code the transcripts preliminarily

Chapter 4. Data analyses and results

This chapter focuses on how I analyzed the data and presents the results. I start the chapter with a series of preliminary analyses to investigate the attributes of key concepts: thinking style, participation in classroom dialogue, and learning outcome, in order to pave the way for examining relationships. The main focus of my study was an investigation of the relationship between thinking style, participation in classroom dialogue and learning outcome. Before exploring the relationship amongst all three variables, I examined how each variable was individually associated with each of the other two especially given the lack of evidence with the age group, namely, participation in classroom dialogue and learning outcomes, thinking style and participation in classroom dialogue; and thinking style and learning outcome. This served as important foundation for conducting moderation analysis to check the model presented in Figure 2.1. I then examined the relationship amongst the three variables and, in particular, I explored whether and how thinking styles affected the relationship between participation in classroom dialogue and learning outcome as represented in the model.

4.1 Analysis and results of thinking style

Firstly, I produced histograms and normal distribution curves relating to the thinking style data (see Appendix E). Such representations provide an initial impression of the data, and lay the foundation for future analyses. This included testing whether the thinking style data from my study were continuous and normally distributed, as these are critical premises for using parametric as opposed to non-parametric analysis (Strand, 2010). As presented in Appendix E, all 13 thinking styles were continuously normal-distributed, indicating that they could be subjected to parametric analysis. I then calculated means and standard deviations for the 13 thinking styles, which provided an initial description of the central tendency and dispersion of the data. Cronbach's alphas were also calculated, as there were 65 items in the TSI-RII, with five items designed to measure each thinking style. I submitted these particular five items to reliability analysis for the purpose of estimating the internal consistencies relating to the 13 thinking styles. Internal consistency is an essential criterion for determining whether data collected by means of a questionnaire are reliable and can be used in further analysis (Muijs, 2004). Cronbach's alphas for the 13 thinking styles needed to be above .60, since this is viewed as the lowest index acceptable for internal consistency (Muijs, 2004). Sternberg, Wagner and Zhang (2007) have proposed the second revised version of the questionnaire, and one of the revisers, Zhang, has conducted a series of studies to testify its reliability. According to Zhang (2010), all of the 13 thinking styles in the TSI-RII are internally reliable, including items used to measure

anarchic style, which are not qualified in previous versions. However, it is noticeable that Zhang's studies have all been conducted with university students (e.g. Zhang, 2010; Zhang & He, 2011; Zhang et al., 2013). My study chose high school students as participants, and thus it was necessary to ascertain the appropriateness of the TSI-RII for assessing the present sample.

Results are shown in Table 4.1 that Cronbach's alphas for thinking styles are generally above .60, except for the anarchic thinking style (.53). In other words, the data indicate that the internal consistencies of thinking styles were generally satisfactory and the TSI-RII is relatively reliable in terms of measuring thinking styles for Chinese high school students. As indicated in Chapter 3, the TSI-RII has proved to be reliable in measuring thinking styles for university students, but has not been tested with school students. My study contributes in this respect. In my MPhil work, two thinking styles, the monarchic and anarchic styles, were omitted for low alpha levels (.55) when I collected data with secondary school students. In the present study, high school students were serving as participants, and could be assumed to have relatively mature self-understanding compared to their secondary school counterparts. The internal consistency for the monarchic style improved from that of the MPhil work, with the alpha coefficients increasing from .55 to .63. The Cronbach's alpha for the anarchic style did not show obvious improvement, suggesting that the TSI-RII is generally reliable and can be used with high school students, but the anarchic style still needs to be modified. Thus the anarchic style was omitted from further analysis.

The mean for the legislative style (5.53) was the highest of the 13 thinking styles, which was the same as for the results reported in my MPhil work. At the same time, one interesting finding was that the mean for the executive style was also quite high (5.30). This indicates that the participants were likely to demonstrate the characteristics of both the legislative style and the executive style. This implies that, on the one hand, students paid attention to course content, following the instructions of teachers and memorizing pre-existing knowledge, but on the other hand, they knew their own characteristics and needs. Additionally, the external style produced another high mean, indicating that many students preferred to communicate with their peers rather than work alone. Standard deviations for the thinking styles were generally around 1.10, with one exception being that of executive style. The low standard deviation for the executive style indicates that the participants showed the least variation in terms of following pre-existing rules and obeying authority.

Table 4.1 Thinking Style Inventory Scales: Alpha coefficients, means and standard deviation (*N*=289)

Scale	*α*	*M*	*SD*
Legislative style	.68	5.53	1.03
Executive style	.64	5.30	0.92
Judicial style	.63	4.76	1.43
Global style	.74	4.24	1.07
Local style	.65	4.35	1.04
Liberal style	.80	4.74	1.15
Conservative style	.70	4.51	1.20
Hierarchical style	.75	4.87	1.14
Monarchic style	.63	4.51	1.10
Oligarchic style	.77	4.90	1.09
Anarchic style	.53	4.11	1.10
Internal style	.72	4.38	1.09
External style	.77	5.39	1.07

Note: *α*= Cronbach's alpha, *M*= Means, *SD*= Standard Deviation

I then submitted the 12 thinking styles to t-tests and one-way ANOVAs, to examine whether there were possible group differences based on gender, school and school class respectively. Previous findings indicate that thinking styles may vary as a function of certain demographic and environmental variables (Zhang, 2010). Gender, school and school class are three variables that are often considered when examining possible group differences in thinking styles (see e.g. Zhang & Sternberg, 2001; Zhu & Zhang, 2011), and were at the same time identifiable from my data. Identifying differences in thinking styles helped with understanding their attributes and more importantly, such differences, once found, could be controlled for testing how relationships thinking styles relate to participation and learning outcome.

As seen in Table 4.2, results from the t-test show that the boys and girls had significantly different tendencies in relation to the liberal, hierarchical and internal styles. Girls (Mean=5.05) had a higher tendency towards the hierarchical style than boys (Mean=4.72). Boys (Mean = 4.88) were more likely to be characterized with the liberal style than girls (Mean= 4.57). Similarly, boys (Mean = 4.51) tended to be more internal than girls (Mean=4.22). There were no significant differences in thinking style

across the schools or classes, indicating that the students from the three schools and six classes could be characterized with similar clusters of thinking styles.

Table 4.2 Differences in thinking styles based on gender, school and class

	Independent sample T-test based on gender		One-way ANOVA test based on school		One-way ANOVA test based on class	
Scale	*t (df*= 285*)*	Sig (2-tailed)	*F(df*= 2, 285*)*	Sig (2-tailed)	*F(df*= 5,282*)*	Sig (2-tailed)
Legislative	1.57	.12	0.04	.96	0.27	.95
Executive	-1.52	.13	1.51	.22	1.08	.37
Judicial	-0.79	.43	0.57	.57	0.87	.52
Global	0.65	.52	0.69	.50	0.48	.82
Local	-1.19	.24	0.55	.58	0.51	.80
Liberal	2.34	.02	0.91	.40	1.09	.37
Conservative	-1.57	.12	0.01	.99	0.20	.98
Hierarchical	-2.52	.01	0.08	.92	0.40	.88
Monarchic	-0.44	.66	0.05	.96	0.19	.98
Oligarchic	-0.27	.79	0.47	.93	1.15	.34
Internal	2.35	.02	0.46	.63	0.60	.73
External	-1.36	.18	0.63	.53	0.30	.94

An exploratory factor analysis (EFA) followed. Many studies, including my MPhil study, have reported that some of the thinking styles proposed by Sternberg are highly correlated with each another (see e.g. Fan & Zhang, 2014; Zhang, 2003; Zhang et al., 2013; Zhu & Zhang, 2011). This may result in misinterpretation of results when conducting subsequent regression analysis due to high multicollinearity[7] (Farrar & Glauber, 1967; Kumar, 1975). In these circumstances, the 12 thinking styles should not be submitted to regression analysis directly, but would rather need to be clustered. Factor analysis meets this requirement and in the event of inter-dependence produces clustered thinking styles, which are appropriate for use in subsequent regression analysis (Field, 2009; Kim & Mueller, 1981). In addition, conducting factor analysis is helpful in data reduction, reducing a large number of variables to a more manageable number of explainable concepts (Field, 2009). With respect to the methods of conducting factor analysis, I selected principal-axis factor analysis with oblique rotation. Principal components analysis is the most frequently used method, as it is simple but effective

[7] According to Kumar (1975), multicollinearity is a statistical phenomenon in which two or more predictor variables in a multiple regression model are highly correlated. This will not give valid results about how each independent variable predicts or affects the dependent variable.

in determining components that explain the variance (Field, 2009). Oblique rotation was chosen as this method allows factors to correlate (Costello & Osborne, 2005). As indicated by Hartas (2009c), human attitudes and beliefs do not present themselves in mutually exclusive forms. With this in mind, factors produced by oblique rotation are less likely to mask important information.

Results are shown in Table 4.3. I obtained a four-factor model for the 12 thinking styles, and the four factors accounted for 65.67 per cent of the variances in the data set. The Kaiser-Meyer-Olkin (KMO) value is 0.72, indicating that sampling was adequate and was able to factorize efficiently the original variables. The significance level of the Bartlett test was less than .01, indicating the four-factor model is appropriate and capable of representing the inner-construct of the 12 thinking styles. The component matrix outputted by SPSS shows the loading of each style onto the components (factors). The first factor was dominated by the liberal, legislative, judicial and hierarchical thinking styles; the conservative, executive, oligarchic and monarchic styles had positive high loadings on Factor 2; Factor 3 was dominated by a high negative loading for the external thinking style as well as a high positive loading for the internal style; Factor 4 captured high loadings of a contrasting pair of thinking styles: global style and local style. This four-factor model was used as a counterpart of the 12 separate thinking styles in subsequent analyses. For descriptive convenience, I labelled each of the factors using the thinking style that had the highest positive loading on the corresponding factor, and thus the four factors were named Liberal Group, Conservative Group, Internal Group and Global Group respectively.

Table 4.3 Factor loadings for the Oblimin-Rotated Factor-Analysis Models (*N*=289)

Scale	Liberal Group	Conservative Group	Internal Group	Global Group
Liberal	**.86**	-.21	.04	-.00
Legislative	**.76**	.11	.15	.18
Judicial	**.72**	-.03	-.21	-.12
Hierarchical	**.41**	.33	-.01	-.25
Conservative	-.34	**.85**	.06	.15
Executive	-.02	**.78**	-.01	.08
Oligarchic	.01	**.69**	-.19	-.04
Monarchic	.20	**.55**	.16	-.12
External	.39	.17	**-.78**	.09
Internal	.43	.12	**.77**	.05
Global	.27	.26	-.02	**.83**
Local	.33	.29	.03	**-.65**
% var.	28.30	16.90	11.36	9.11
C. var.	28.30	45.20	56.55	65.67
Eigenvalue	3.40	2.03	1.36	1.09

Note: % var. = % of Variance, C. var.= Cumulative variance. The dominant styles within each factor are shown in bold.

Section 4.1 can be summarized as follows. The data on thinking styles are normally distributed and can be subjected to parametric analysis. The internal consistency of the anarchic style was low and therefore it was omitted, leaving 12 styles within the study. Factor analysis indicated that the 12 styles were clustered into four types of style. For descriptive convenience, I named each of the factors using the thinking style that had the highest positive loading on the corresponding factor, and thus the four factors were named the Liberal-Group style, Conservative-Group style, Internal-Group style and Global-Group style. There were significant difference between boys and girls in terms of their thinking styles, and thus gender was taken into account in further analysis. The schools and classes within schools did not differ significantly.

4.2 Analysis and results of participation in classroom dialogue

4.2.1 Analysis and results of talk in classroom dialogue

As noted in Chapter 2, Chinese students are traditionally portrayed as passive in classroom talk. Recently, since launching the 'character building' education reform, classroom participation appears to have increased, and it is necessary to build a more accurate image of how Chinese learners talk in classrooms. This section addresses this issue.

Eighteen observations (six days × three lessons observed on each day) were conducted in each of the selected classes. Every time a student made a contribution to classroom dialogue, this was marked as one instance on the grid under the corresponding category after the relevant student's coding number. Firstly, I counted the number of times that each individual contributed under the 13 categories (see Appendix B). During class observation, I found that the teachers gave students different opportunities to talk in class, with some teachers encouraging students to talk while others just continued to teach without inviting contributions. For example, in one physics class, almost all students' verbal contributions were marked zero and it was not possible to tell whether students were willing to engage in classroom talk. In order to reduce teacher effects on students' participation, I added together the number of contributions that each student made in mathematics, physics and English lessons. This served as the raw data concerning talk during classroom dialogue, based on which I produced histograms and normal distribution curves. As seen in Appendix F, the data concerning talk were all left-censored[8]with a large number of zeroes, indicating that the scales of talk were not amenable to parametric analysis.

As with thinking styles, I calculated means and standard deviations for the scales of talk, which allowed me to understand the central tendency and dispersion of the data. Results are presented in Table 4.4. With regard to the categories used to code frequency of talk (i.e. TISC, TISNC, TNISC and TNISNC), TISC had the highest mean (7.39), indicating that, in these Chinese high school classes, the main form of contributing to classroom dialogue was answering questions raised by teachers when answering was allowed. It is noticeable that the standard deviation of TISC was also the highest (7.69). This reveals that the verbal contributions made by students varied a great deal, with some students talking frequently, while others tended to remain silent. The mean for TISNC was quite low, implying that teachers would give students opportunities to talk when they expressed an intention to participate (e.g. raising hands and nodding to teachers).

[8] The data under a certain value, usually zero, cannot be known, which is termed 'left-censored' data.

In terms of the quality of talk, the mean for correct was quite high (4.22), meaning that students had a high rate of accuracy when they answered questions. This in a way suggested that participants generally had a good mastery of course content. Another way of explaining this phenomenon is that students were more likely to talk in class when they were confident about their answers. Also, most of the topics of classroom dialogue involved a review of prior knowledge and course content, but rarely personal experience, which can be seen through comparing the means for prior knowledge and personal experience. As regards the cognitive level of talk, the mean for analysis (4.98) was the highest among the four categories (i.e. generalization, analysis, speculation and uptake). This indicated that analyzing problems was highlighted by the teachers in my sample and the students received much of their teaching in this area through dialogue, while other abilities, like generalization and speculation, were less likely to be employed in class. Also, the students often talked about their own ideas, but they rarely took up previous contributions.

Table 4.4 Scales of participation in classroom dialogue: Means and standard deviation (*N*=289) (using the raw data)

Scale	*M*	*SD*
TISC	7.39	7.69
TISNC	0.47	0.81
TNISC	3.80	5.00
TNISNC	0.49	0.71
Incorrect	0.69	0.96
Partially correct	2.07	2.17
Correct	4.22	5.40
Prior knowledge	6.11	6.85
Personal information	0.52	0.71
Generalization	0.53	0.94
Analysis	4.98	6.51
Speculation	0.28	0.61
Uptake	0.50	1.20

To facilitate interpretation, I transformed the raw data using the steps described below, and the frequency and quality of talk in classroom dialogue were analysed separately. As regards the frequency, the number of times that each individual contributed under the categories TISC, TISNC, TNISC and

TNISNC were used to represent how frequently a student spoke, and a higher number meant that the student was more active in making contributions to classroom dialogue. As regards analysing for quality, I also counted the number of times that each student contributed. Subsequently, I attributed values 1, 2 and 3 to 'incorrect', 'partially correct' and 'correct', respectively, 1 to subcategories of 'assumed-known information' (i.e. 'prior knowledge' and 'personal information'), and 2 to subcategories of 'reasoning' (i.e. 'generalization', 'analysis', 'speculation' and 'up-take'), that was multiplying the values by the number of times under each category. For instance, one student contributed 13 instances of correct answers, and this student's transformed data under the 'correct' category would be 39 (13 times × value 3). The values represented different levels of contribution, and a higher value suggested that a contribution was of higher quality. A correct answer is viewed as more challenging to produce than a partially correct answer or an incorrect answer (Brophy & Good, 1970), and thus the values for these three categories were in descending order. Also, more complex thinking processes are involved when students show reasoning, while recalling assumed-known information is considered to be less demanding (Chin, 2006). Thus the subcategories relating to 'reasoning' were given a higher value than those for 'assumed-known information'. The transformed data were easier to interpret, and were used in subsequent analyses.

As shown in Table 4.5, indices of quality of talk (i.e. incorrect, partially correct, correct, prior knowledge, personal information, generalization, analysis, speculation and uptake) were significantly positively correlated with each other. This indicates that the indices could be combined. Thus the multiplied scores were added together to represent the quality of talk that each student contributed, for subsequent use in moderation analysis (see Section 4.7). This was because the number for each separate index of talk was small, making it difficult to show statistical significance in a moderation model.

Table 4.5 Correlations between indices of quality of talk (*N*= 289)

Cognitive abilities	Inc	Pac	Cor	Pri	Per	Gen	Ana	Spe
Pac	.51**							
Cor	.29**	.67**						
Pri	.48**	.86**	.88**					
Per	.21**	.38**	.40**	.43**				
Gen	.17**	.46**	.64**	.59**	.40**			
Ana	.37**	.77**	.90**	.89**	.41**	.64**		
Spe	.18**	.44**	.62**	.56**	.24**	.57**	.62**	
Upt	.17**	.46**	.66**	.59**	.28**	.61**	.65**	.81**

Note: Inc= Incorrect; Pac= Partially correct; Cor= Correct; Pri= Prior knowledge; Per=Personal information; Gen= Generalization; Ana= Analysis; Spe=Speculation; Upt= Uptake. $^{*}p < 0.05$, $^{**}p < 0.01$.

As summarized in Howe and Abedin (2013), gender, ethnicity and academic achievement are the three factors that are most frequently related to classroom dialogue, and they are often found to be significantly correlated with students' participation in such dialogue (see Section 2.5.1). The relationship between academic achievement and participation was one of my main focuses, and academic achievement was certainly considered. The participants in my study were all Chinese, and thus ethnicity was not a relevant element. Gender could be a potential influence when investigating the relationship between thinking style, participation and learning outcomes. Thus I identified whether there was a group difference in talk between boys and girls. Additionally, group differences in talk based on school and school class were also examined. A Mann-Whitney U-test was used for identifying gender difference, and Kruskal-Wallis tests were employed to identify group differences based on school and class. These two methods are typical statistical methods used to identify group differences when data are not normally distributed (Hartas, 2009d).

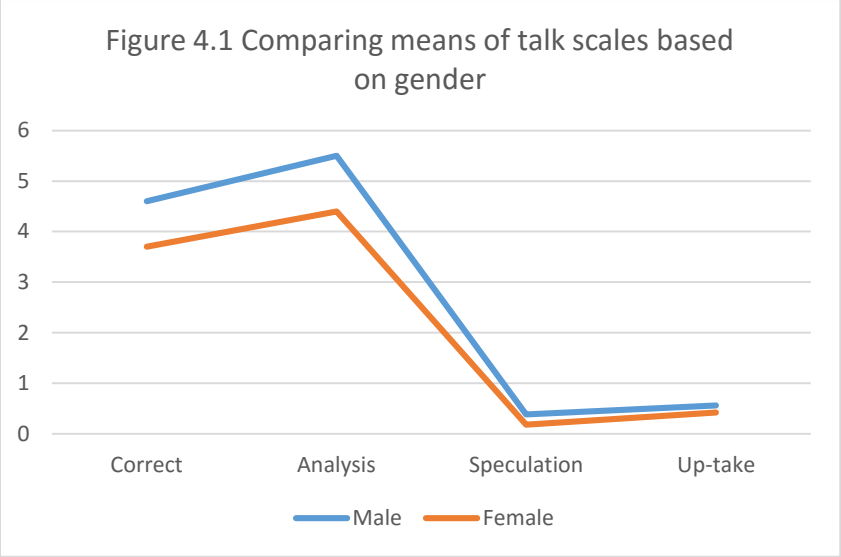
The results are shown in Table 4.6, revealing that the boys and girls were similar over the frequency of talk, but there were significant differences between them over the quality of talk, which corresponds exactly with the results reported in some other studies (e.g. Duffy et al., 2001; Younger et al., 1999). To be more specific, gender had a significant influence on a few indices of talk in classroom dialogue. Boys obtained significantly higher scores than girls in four categories, namely, correct, analysis, speculation and up-take (see Figure 4.1[9]).

[9] In Figures, I merely illustrate the categories in which different groups of students show significantly different performances.

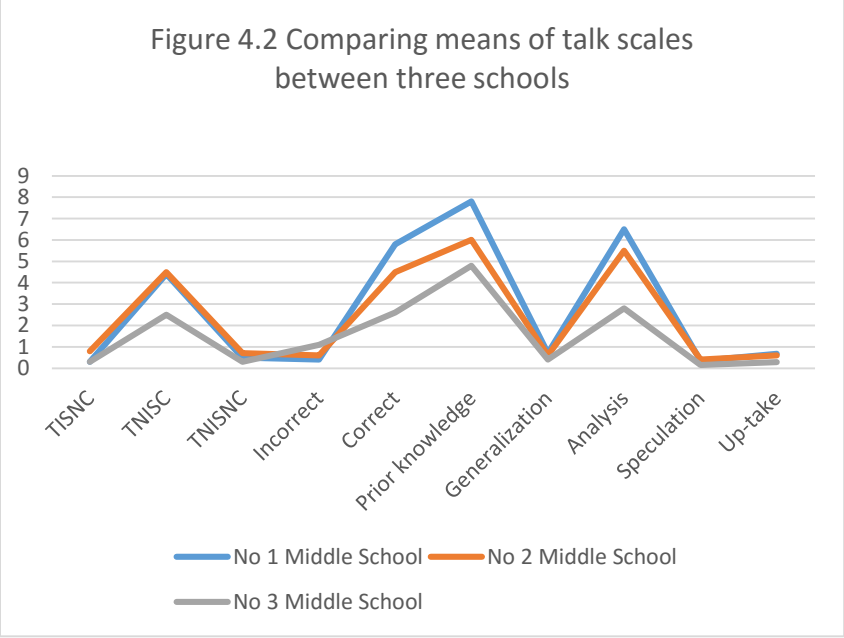
Table 4.6 Differences in participation based on gender, school and class

(Using transformed data)

	Mann-Whitney u-test based on gender		Kruskal-Wallis test based on school		Kruskal-Wallis test based on class	
Scale	*Z(df*=285*)*	Sig (2-tailed)	χ^2 *(df*=2, 285*)*	Sig (2-tailed)	χ^2*(df*=5, 282*)*	Sig (2-tailed)
TISC	-1.89	.06	6.12	.05	6.60	.25
TISNC	-0.06	.95	21.09	.00	23.78	.00
TNISC	-2.05	.06	10.80	.01	20.20	.00
TNISNC	-1.58	.11	13.97	.00	16.70	.01
Incorrect	-0.74	.46	22.71	.00	23.40	.00
Partially correct	-1.59	.11	6.13	.05	8.42	.13
Correct	-2.09	.04	14.42	.00	16.80	.01
Prior knowledge	-1.76	.08	8.14	.02	8.44	.13
Personal information	-0.70	.49	0.62	.73	5.52	.36
Generalization	-1.15	.25	6.89	.03	11.16	.04
Analysis	-2.11	.04	16.56	.00	18.11	.00
Speculation	-2.41	.02	10.64	.01	14.35	.01
Uptake	-2.11	.04	9.09	.01	11.80	.04
Frequency	-2.07	.06	7.41	.03	9.57	.09
Quality	-2.12	.03	10.31	.01	12.33	.03

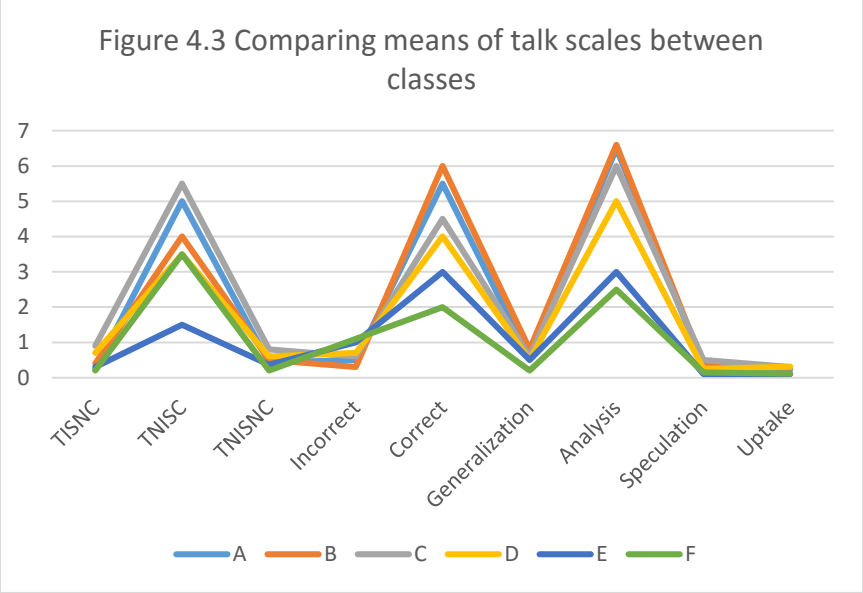


Students from different schools generally made significantly varied verbal contributions to classroom dialogue, except in the categories, TISC, partially correct and personal information. Seen from Figure 4.2, the variance was not only shown in the number of times each students talked in class, but was also obvious in the quality of talk. Students in No. 1 Middle School generally made the most contributions in classroom dialogue, which was followed by the students from No. 2 Middle School. It is noticeable that the gap between these two schools was small. Students in No. 3 Middle School made the least contributions among the three schools in most of the categories.



Classes A and B were from No. 1 Middle School, classes C and D were from No. 2 Middle School, and classes E and F belonged to No. 3 Middle School. As seen in Figure 4.3, students in the classes within each school were similar to each other in terms of their performance in talk, such that analysis

at the class level largely replicated analysis at the school level. Students from different school classes were similarly likely to answer questions raised by teachers (TISC), contribute partially correct answers and describe their personal experiences. Besides, students from different school classes had significantly varied performances in the other categories of talk. Students' contributions had large gaps in terms of categories TNISC, correct and analysis.



To summarize, Section 4.2.1 has three main findings. Firstly, the data on talk in classroom dialogue were left-censored, and only suitable for non-parametric analysis. Secondly, the means for TISC, correct, prior knowledge and analysis were generally high compared to other categories. Thirdly, students of different genders, schools and school classes had significantly different performances in terms of talk in classroom dialogue, and thus these three factors would have to be taken into account when talk was related to thinking style and learning outcome.

4.2.2 Analysis and results of listening in classroom dialogue

The literature reviewed in Section 2.2.1 has indicated that silent students who learn through listening should be seen as participants in classroom dialogue, and were considered in my study. Yet very few scholars view listening as a form of participation in classroom dialogue, and there is a scarcity of ready-made questionnaires that could be applied directly to my study. Thus I designed a questionnaire to measure students' listening in classroom dialogue. Of the 15 items in the questionnaire, the first five items were intended to measure the frequency of listening, and the remaining ten were intended to measure the quality of listening in two respects, namely, listening experiences and perception of achievement. This section, on one hand, considers whether the instrument designed to measure classroom listening is reliable and valid, and on the other hand, illustrates how the students were involved in classroom dialogue through listening.

According to Hartas (2010b), when developing an instrument, reliability and validity should be considered. Construct validity reflects the "conceptual coherence between a construct" (Hartas, 2010b, p. 75). Internal consistency determines whether items reflect the same construct they are supposed to measure (Field, 2009). To ensure construct validity, I firstly conducted an exploratory factor analysis (EFA) in SPSS, as this method is typically used to demonstrate whether items actually reflect the constructs scholars want to investigate (Field, 2009; Kim & Mueller, 1981). Table 4.7 shows the results, which yielded four factors. Items 6-10 with high loadings on Factor 1 were those designed to measure listening experience. Factor 2 was dominated by positive high loadings of items (i.e. items 1-5) used to measure frequency of listening. Items 14 and 15 had high loadings on Factor 3, and Factor 4 was dominated by negative high loadings of items 11, 12 and 13. The results generally fitted with my design, although the items used to measure perception of achievement were split between Factors 3 and 4.

Table 4.7 Factor loadings for the Oblimin-Rotated Factor-Analysis Models (*N*=289)

Scale	Factor 1	Factor 2	Factor 3	Factor 4
8. In the class, I feel uncomfortable when I ask questions.	**.81**	-.08	.21	.15
6. In the class, I feel uncomfortable when I answer questions.	**.77**	-.08	.05	-.05
7. In the class, I feel uncomfortable when I discuss with other students publicly.	**.75**	.02	-.04	-.01
9. In the class, I feel comfortable when I remain silent but listen to other students' talk.	**.59**	.07	.04	-.13
10. In the class, I feel comfortable when I remain silent but listen to the teacher's instructions.	**.55**	.09	-.07	-.36
1. I listen to the teacher's instructions.	-.06	**.73**	.08	.01
2. I listen to other students' talk when they answer questions.	.13	**.72**	-.09	.07
5. I take notes while I am listening in class.	-.06	**.67**	.23	-.07
3. I listen to other students' discussion.	.06	**.62**	-.17	.30
4. I do not day-dream during class.	-.17	**.56**	-.04	-.26
15. I apply existing knowledge to solve novel problems better when I remain attentively silent in classroom dialogue.	-.05	.02	**-.86**	-.02
14. I come up with more creative ideas when I remain attentively silent in classroom dialogue.	-.01	-.04	**-.85**	-.09
13. I solve problems better when I remain attentively silent in classroom dialogue.	.07	.01	.02	**-.79**
12. I think more critically when I remain attentively silent in classroom dialogue.	.00	-.08	-.14	**-.77**
11. I memorize knowledge better when I remain attentively silent in classroom dialogue.	.15	.01	-.04	**-.71**
% var.	23.58	14.96	11.04	8.42
C. var.	23.58	38.54	49.58	58.00
Eigenvalue	3.54	2.24	1.66	1.26

Note: % var. = % of variance, C. var.= Cumulative variance. The dominant classroom performances within each factor are shown in bold.

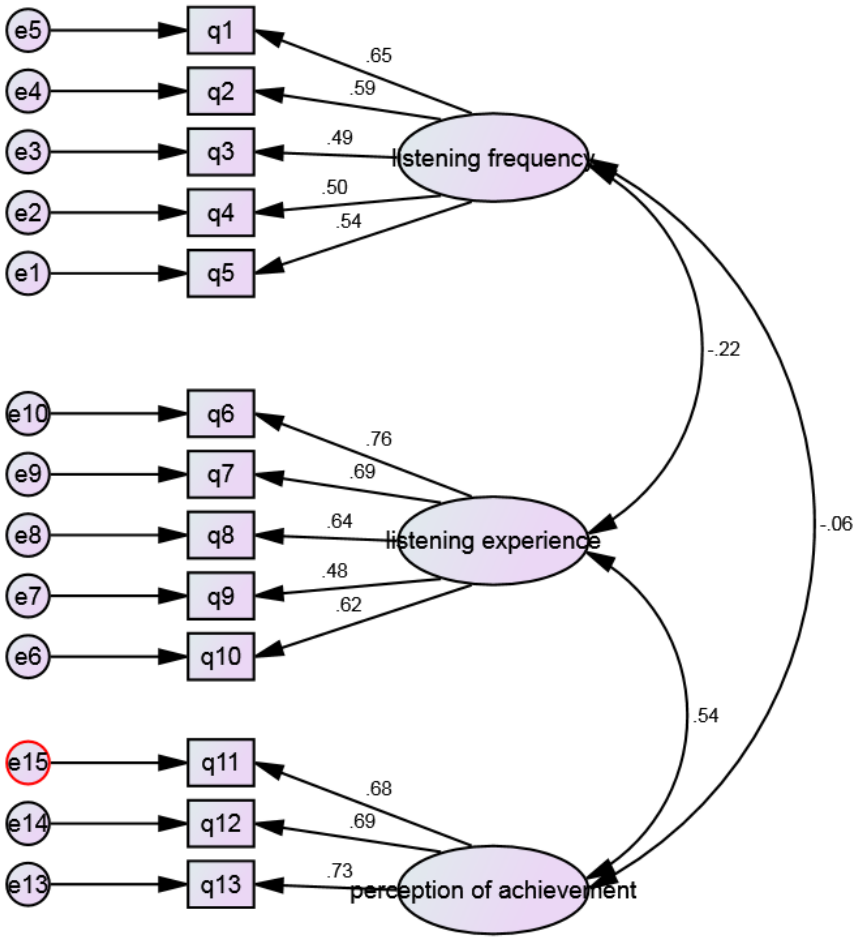
As a check, I conducted a confirmatory factor analysis (CFA) and built up a model in AMOS (see Figure 4.4). CFA is a statistical technique used to verify the factor structure of a set of observed variables. This techique allows the researcher to test the hypothesis that a relationship between

observed variables and their underlying latent constructs exists. According to Lei and Wu (2007), CFA can be used to evaluate and modify the validity of substantive theories with empirical data. CFA takes a confirmatory approach to determine "whether a hypothesized theoretical model is consistent with the data collected to reflect the theory" (p.34). The consistency is reflected through model fit. There is a handful of indices that can be used to reflect a good level of model fit, in which significant levels of the chi-square statistic, goodness-of-fit index (GFI), adjusted GFI (AGFI) and the root mean square error of approximation (RMSEA) method are generally recommended for evaluation.

The results show that the model fit was improved with satisfactory parameter values when I deleted items 14 and 15 (p value = .000 < .01, GFI = .92 > .88, AGFI = .90 > .86, RMSEA = .06 < .08). This indicates that items 11, 12 and 13 were capable of representing the scale perception of achievement, while there was no need for items 14 and 15. The insignificance of items 14 and 15 might have been due to the fact that knowledge application and finding creative answers were less likely to happen in a Chinese class, and would have little value in terms of satisfying the requirements of the curriculum. It was no wonder that these two situations were perceived to have almost no effect on students' perceptions of achievement. Thus, after making corrections, items 11-13 were retained to measure the perception of achievement through listening, while items 14 and 15 were deleted.

When I designed the questionnaire, items 6-15 were proposed in order to measure quality of listening, with items 6-10 measuring from the perspective of listening experience and the next five items from the perspective of perception of achievement. Results obtained from the pilot study showed that items 6-15 were highly loaded on one factor, indicating the overall construct, quality of listening, could be used to represent the two separate components (i.e. listening experiences and perception of achievement). However, as demonstrated above, data collected from my formal fieldwork showed a different result. Both exploratory and confirmatory factor analyses implied to keep the two separate components. Given that more students were involved in the formal fieldwork compared with those in the pilot, the results obtained seemed to be closer to the real situation. Besides, combining those items from 6-15 could have carried the risk of missing important information. Therefore I decided to keep the two components, namely, listening experience (items 6-10) and perception of achievement (items 11-13), in further analyses.

Figure 4.4. Structural equation modelling of listening scales



After making the above correction, the reliability of the questionnaire needed to be evaluated. I calculated Cronbach's alphas, as the index is a good reflection of internal consistency (Hartas, 2009b). Results showed that Cronbach's alphas for the frequency of listening, listening experience and perception of achievement were above .60, which indicates that the designed questionnaire was internally reliable in terms of measuring listening in classroom dialogue. I also computed means and standard deviation for scales of listening to capture initial characteristics of the data. As seen in Table

4.8, the mean for frequency of listening was rather high, 4 in a scaled that ranged from 0 to 5, while its standard deviation was low. This indicates that participants generally saw themselves as paying careful attention to classroom teaching and other students' contributions. The means for listening experience and perception of achievement were lower, while their standard deviations were higher. This indicates that participants reported to have rather varied experiences and learning achievement when they listened in classroom dialogue, with some students feeling comfortable and achieving a great deal, while others had a less ideal learning experience.

Table 4.8 Students' performance with regard to listening in classroom dialogue (*N*=289)

	α	*M*	*SD*
The frequency of listening	.68	4.00	0.51
Listening experience	.77	3.12	0.84
Perception of achievement	.74	2.98	0.93

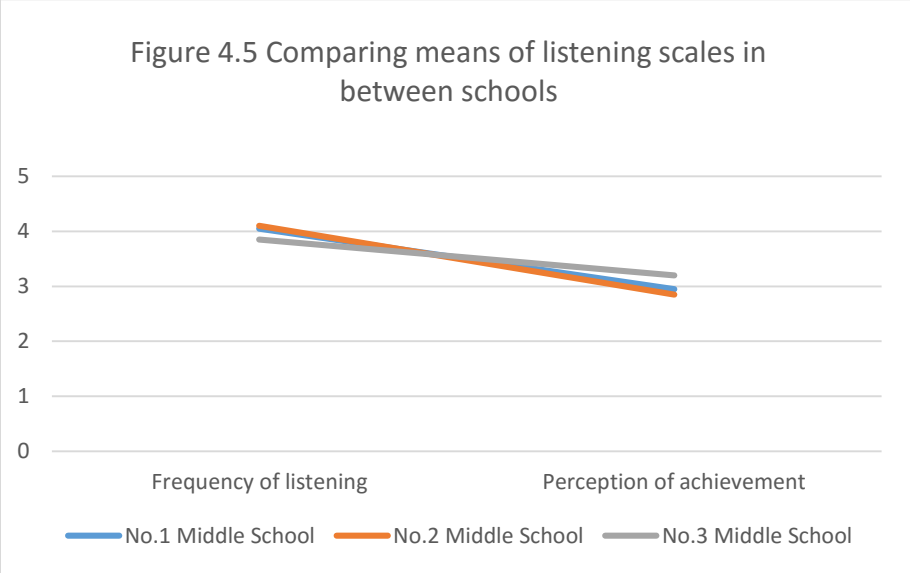
Note: *α*= Cronbach's alpha, *M*= Means, *SD*= Standard Deviation

Histograms and normal-distributed curves were exported to provide an initial impression of data attributes (see Appendix G), and the figures indicated that the frequency, listening experience and perception of achievement were suitable for parametric analysis. Few scholars have studied students' listening in classroom dialogue before, and it is unclear which factors are likely to affect students' listening in class. In this study, I viewed listening as a form of participation in classroom dialogue, and thus the factors (i.e. gender, school, and school class) associated with talk in classroom dialogue might also have affected listening. As in the case of talk, I tested group differences based on gender, school and school class using an independent t-test and one-way ANOVAs respectively.

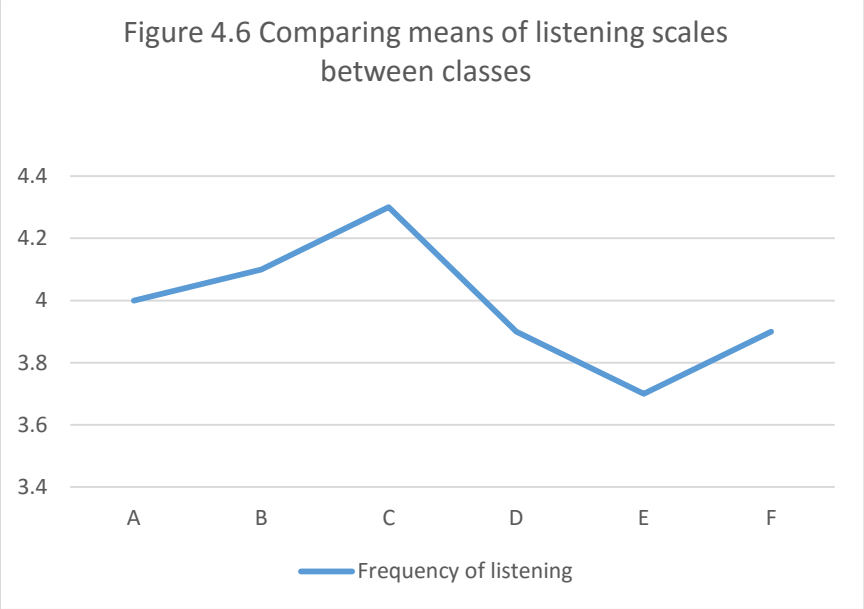
Table 4.9 Differences in listening performance based on gender, school and class

	Independent sample T-test based on gender		One-way ANOVA test based on school		One-way ANOVA test based on class	
Scale	*t(df*=285*)*	Sig (2-tailed)	*F(df*=2, 285*)*	Sig (2-tailed)	*F(df*=5, 282*)*	Sig (2-tailed)
The frequency of listening	-4.55	.001	6.90	.00	5.62	.001
Listening experience	-0.12	.90	2.40	.09	1.57	.16
Perception of achievement	1.55	.12	3.30	.02	2.03	.06

Table 4.9 demonstrates that there was a significant difference in the frequency of listening between boys and girls. Girls (Mean=4.14) reported themselves as having a longer attention span during classroom teaching than boys (Mean=3.87). Generally, boys (Mean=3.09) and girls (Mean=3.04) had a similar level of listening quality during classroom dialogue. Students from the three schools performed significantly differently with regard to listening in classroom dialogue. As seen in Figure 4.5, the main difference over the frequency of listening was the students from No.1 and No. 2 Middle Schools reporting that they spent more time listening to teachers and other students talking than the students from No. 3 Middle School. Also, the students from the different schools perceived themselves to have different levels of learning quality when listening in classroom dialogue. Students from No. 3 Middle School ranked themselves as highest in terms of perception of achievement.



Additionally, the students in the different school classes performed differently with regard to frequency of listening in classroom dialogue (see Figure 4.6). Students in Classes E, the one selected from No. 3 Middle School, reported themselves to be the lowest in paying attention to course content through listening.



Section 4.2.2 can be summarized as follows. The data on listening in classroom dialogue was normally distributed. The newly-designed questionnaire was generally reliable and valid in measuring listening in classroom dialogue. Exploratory and confirmatory factor analyses indicated that, after deleting items 14 and 15, the questionnaire showed satisfactory construct validity. Also, the questionnaire was internally consistent in measuring frequency, listening experience and perception of achievement through listening. Gender significantly affected the frequency of listening, and students from different schools and school classes had significantly varied performances in terms of listening.

4.3 Analysis and results of learning outcomes

4.3.1 Analysis and results of academic achievement

Each student's mathematics, physics and English scores were used to represent his/her academic achievement in these three subjects respectively. The maximum score possible for the three subjects was 150 points. Like those concerning thinking style and participation, I also produced histograms and normal distribution curves for the data concerning academic achievements to identify whether they satisfied the conditions for parametric analysis. Figures in Appendix G confirmed suitability for parametric analysis.

Means and standard deviations for achievements in the three subjects were then calculated for the purpose of providing a preliminary understanding of the data. As seen in Table 4.10, the mean for English achievement was the highest, indicating that the students were most likely to perform well in English. The standard deviation for mathematical achievement ranked highest among the three subjects,

which suggests that participants were more variable in their mathematics learning, with some performing extremely well and others poorly.

Table 4.10 Academic achievement Scales: Means and standard deviation (*N*=289)

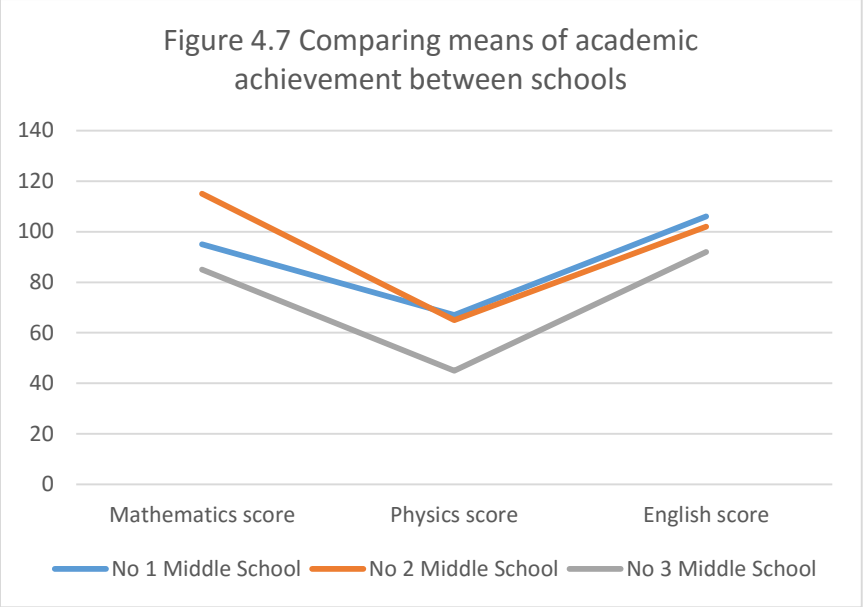
Scale	*M*	*SD*
Mathematics achievement	97.66	21.81
Physics achievement	60.36	15.28
English achievement	99.84	17.23

Next these three achievements were submitted to independent t-tests and ANOVAs in order to ascertain whether there were significant group differences in learning outcomes based on gender, school and school class.

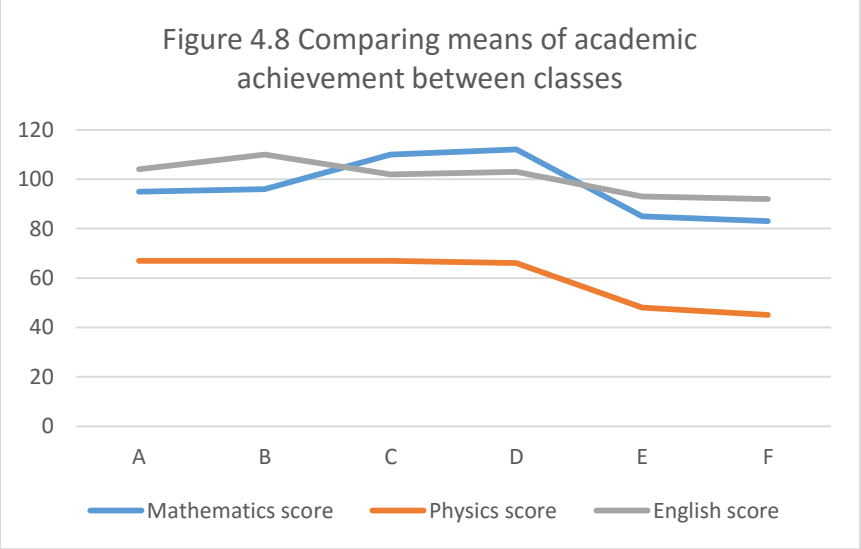
Table 4.11 Differences in academic achievement based on gender, school and class

	Independent sample T-test based on gender		One-way ANOVA test based on school		One-way ANOVA test based on class	
Scale	*t* (*df*=285)	Sig (2-tailed)	*F* (*df*=2, 285)	Sig (2-tailed)	*F* (*df*= 5, 282)	Sig (2-tailed)
Mathematic achievement	3.77	.001	57.37	.001	19.50	.001
Physics achievement	3.09	.001	93.09	.001	31.11	.001
English achievement	-3.98	.001	20.77	.001	7.22	.001

As seen in Table 4.11, there were significant differences in academic achievement between boys and girls. Boys (Mean=101.98) scored significantly higher than girls (Mean= 92.49) in mathematics. Similarly, boys (Mean=62.90) had higher score in physics than girls (Mean= 57.41). Conversely, girls (Mean=104.02) had significantly higher scores in English than boys (Mean=96.13). As shown in Figure 4.7, the students from the different schools also differed significantly over performance in the examinations. In terms of mathematics, students from No. 2 Middle scored highest; students from No. 1 and No. 2 Middle School had similar performance in English and physics, with the former scoring slightly higher. In comparison, students from No. 3 Middle School had significantly lower academic achievements in all three subjects than those from the other schools.



Similarly, students coming from different school classes also performed significantly differently in terms of academic achievement in the three different subjects (see Figure 4.8). Students in the two classes within one school generally had similar academic achievement. The Class difference replicates the school effects.



4.3.2 Analysis and results of cognitive abilities

The STAT instrument designed by Sternberg (1993) was used to measure cognitive ability, in which nine dimensions of ability were derived, namely, verbal analytical, quantitative analytical, figure analytical, verbal creative, quantitative creative, figure creative, verbal practical, quantitative practical and figure practical abilities. Histograms and normal distribution curves relating to the nine dimensions of cognitive abilities indicated that the nine abilities were all suitable candidates for parametric analysis (see Appendix G).

Means and standard deviations were then calculated. As shown in Table 4.12, the means for the nine cognitive abilities were generally around 2.50. Quantitative analytical ability resulted in the highest mean (2.98), which indicates that students were most likely to show good performance in quantitative analysis. This result might have been due to the fact that Chinese teachers tend to use a large number of exercises in classroom teaching and pay special attention to how students analyze problems, especially in mathematics classes. Also, the students had rather low mean scores in relation to the quantitative practical (1.99) and figure practical (1.31) abilities, indicating that the participants were not good at applying existing knowledge to solving novel problems.

Table 4.12 Cognitive abilities Scales: Means and standard deviation (*N*=289)

Scale	*M*	*SD*
Verbal analytical	2.02	0.96
Quantitative analytical	2.98	1.09
Figure analytical	2.58	1.07
Verbal practical	2.34	0.94
Quantitative practical	1.99	1.09
Figure practical	1.31	0.99
Verbal creative	2.42	1.03
Quantitative creative	2.35	1.20
Figure creative	2.00	1.07

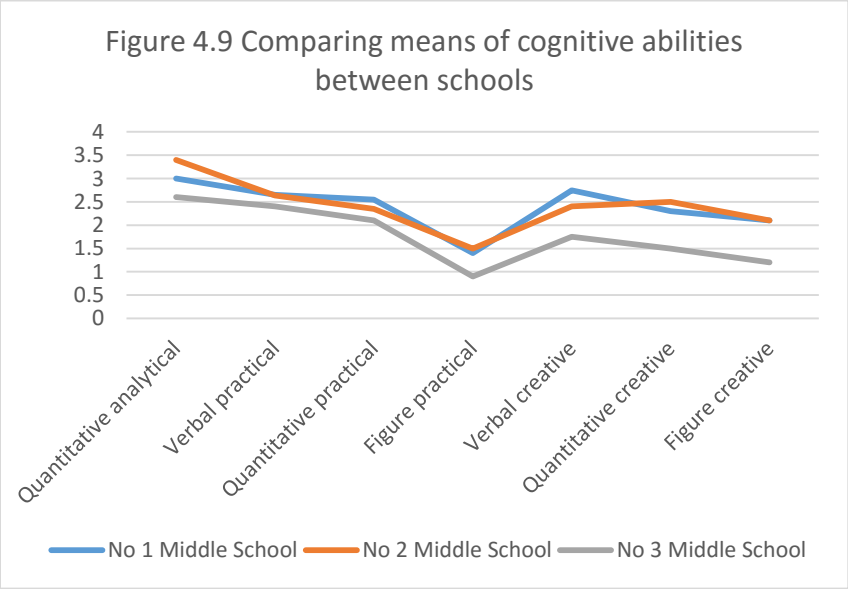
Next I checked whether or not students' cognitive abilities varied according to gender and school, and school class, with an independent t-test used for testing gender effects, and ANOVAs applied to check the effects of school and class. Results presented in Table 4.13 indicate that in general boys and girls were relatively similar as regards cognitive abilities. One exception is that there was a significant gender difference over quantitative analysis. Boys (Mean= 3.14) displayed higher levels of quantitative analytical ability than girls (Mean= 2.80).

Table 4.13 Differences in cognitive abilities based on gender, school and class

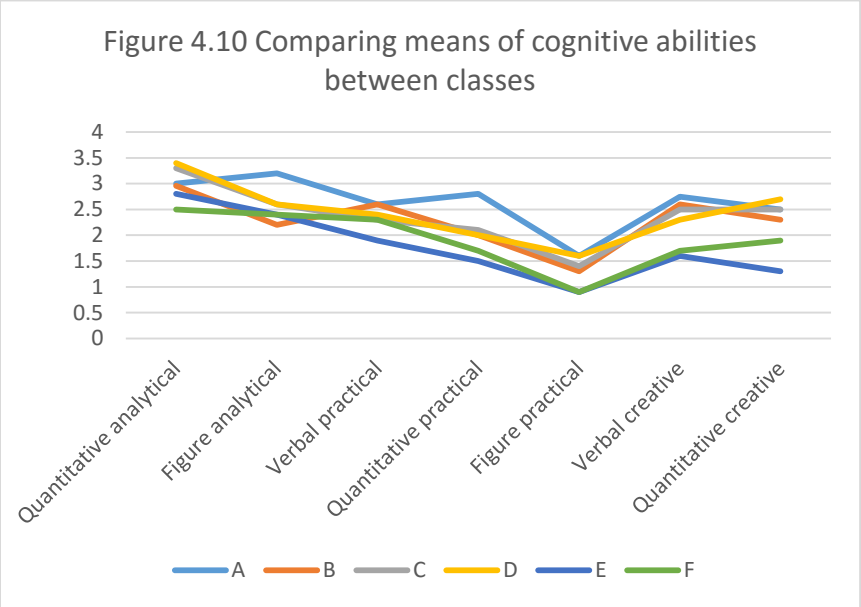
	Independent sample T-test based on gender		One-way ANOVA test based on school		One-way ANOVA test based on class	
Scale	*t* (*df*= 285)	Sig (2-tailed)	*F* (*df*= 2, 285)	Sig (2-tailed)	*F* (*df*= 5, 282)	Sig (2-tailed)d)
VA	-0.95	.34	0.08	.93	0.67	.68
QA	2.71	.01	10.31	.00	3.82	.00
FA	-0.08	.94	2.07	.13	4.66	.00
VP	0.41	.68	5.29	.01	2.80	.01
QP	0.88	.38	16.55	.00	9.30	.00
FP	1.01	.32	8.77	.00	3.90	.00
VC	-1.04	.30	18.15	.00	6.30	.00
QC	1.12	.27	6.01	.00	2.45	.03
FC	-0.80	.55	5.05	.01	2.04	.06

Note: VA= Verbal analytical ability, QA= Quantitative analytical ability, FA= Figure analytical ability, VP= Verbal practical ability, QP= Quantitative practical ability, FP= Figure practical ability, VC= Verbal creative ability, QC= Quantitative creative ability, FC= Figure creative ability.

Students from different schools generally showed significantly different levels of cognitive abilities (see Figure 4.9). A similar level of cognitive abilities was evidenced by students in No. 1 and No. 2 Middle Schools, while students from No. 3 Middle School displayed significantly low levels. This seemed to be the result of the particular way in which these Chinese high schools were organized and ranked.



The cognitive abilities between the six classes were significantly different (see Figure 4.10). There were wide gaps between the two classes in No. 1 Middle School in terms of figure analytical and quantitative practical abilities. Students from the two classes in No.2 Middle School performed similarly. Students from classes E and F, namely those in No. 3 Middle School, also had similar performance, and generally ranked the lowest level of cognition.



I had intended to use factor analysis to reduce the nine cognitive abilities to a smaller number of factors. A preliminary phase in factor analysis involves checking the magnitude of interrelations among the selected variables, and they are expected to correlate with each other to a degree of at least around .3 (Hartas, 2009c). I checked the initial correlations among the nine cognitive abilities via a matrix of correlation coefficients, and I found that most of the coefficients were around .1 (see Table 4.14). This suggested factor analysis was not appropriate for use in data reduction and thus all nine cognitive abilities were considered in subsequent analyses.

Table 4.14 Correlation matrix between cognitive abilities (*N*= 289)

Cognitive abilities	QA	FA	VP	QP	FP	VC	QC	FC
VA	.14	.14	-.01	.08	.11	.18	.09	.15
QA		.18	.06	.21	.14	.17	.24	.15
FA			.09	.16	.11	.19	.06	.16
VP				.22	.14	.18	.05	.10
QP					.14	.22	.22	.18
FP						.16	.17	.25
VC							.18	.19
QC								.32

Note: VA= Verbal analytical ability, QA= Quantitative analytical ability, FA= Figure analytical ability, VP= Verbal practical ability, QP= Quantitative practical ability, FP= Figure practical ability, VC= Verbal creative ability, QC= Quantitative creative ability, FC= Figure creative ability.

4.3.3 Analysis and results of the relationship between academic achievement and cognitive abilities

Academic achievement is most commonly used to represent students' learning outcomes. However, some scholars have indicated that academic achievement pays less attention to students' capabilities in relation to critical thinking and deep processing of information (Gijbels et al., 2014; James & Brown, 2005), and too often only reflects part of their learning outcomes (Vermunt, 2005). In order to explore how well academic achievement reflected students' learning and whether it overlooked evaluation of cognitive abilities, I conducted Pearson correlation analyses to investigate the relationship between academic achievement and cognitive abilities.

As seen in Table 4.15, there were significant associations between academic achievement and cognitive abilities. Generally, correlation coefficients were all positive, which, in one way, could be justified as the higher the cognitive abilities a student showed, the better he/she achieved in the academic examination; or students who achieved high scores would usually demonstrate a high level of cognition. Mathematical achievement had significantly positive correlations with quantitative analytical, figure analytical and figure practical abilities. The correlation coefficient between mathematical achievement and quantitative analytical ability was the highest, indicating that students who had a higher ability in terms of quantitative analysis were most likely to achieve better scores in mathematics. Physics achievement was positively correlated with many of the abilities - quantitative

analytical, figure analytical, quantitative practical, figure practical, verbal creative, quantitative creative and figure creative abilities. This in a way reveals that the physics examination placed higher and more comprehensive requirements on students' abilities. English achievement was significantly and positively associated with verbal analytical ability, while no significant correlations with verbal practical and verbal creative abilities were found. This implies that Chinese schools emphasize analysis of language in English learning while paying less attention to the practical use of and innovation in language.

Table 4.15 Correlation coefficients for the relationship between academic achievement and cognitive abilities (*N*=289)

	Mathematic achievement	Physics achievement	English achievement
Verbal analytical	.07	.09	.12*
Quantitative analytical	.36**	.27**	.04
Figure analytical	.18**	.17**	.05
Verbal practical	-.03	.05	-.02
Quantitative practical	.11	.30**	.09
Figure practical	.15*	.19**	.06
Verbal creative	.06	.20**	.03
Quantitative creative	.07	.18**	.07
Figure creative	.08	.25**	.04

*$p < 0.05$, ** $p < 0.01$

The main points of Section 4.3 can be summarized as follows. There were significant differences in academic achievement and cognitive abilities based on gender, school and school class. The mean for quantitative analytical ability was the highest among the other abilities. Students' academic achievements were significantly correlated with some of their cognitive abilities, especially analytical ability.

4.4 Analysis and results of relationship between participation in classroom dialogue and learning outcomes

This whole project derived from literature indicating that participation in classroom dialogue is related to learning. From this literature, it would be expected that students who participate in classroom

dialogue through talk and listening are likely to learn well. In order to test this, the relationship between participation and learning outcomes was examined. I firstly conducted zero-order correlations, with the Spearman correlation method used for talk and the Pearson correlation method used for listening. A spearman correlation is a non-parametric test that is used to measure the degree of association between two variables, when at least one of them is not normally distributed. Pearson correlation measures the degree of the relationship between linearly related variables and the variables should be normally distributed (Field, 2009).

Tables 4.16 and 4.17 give Spearman correlation coefficients between the indices of talk in classroom dialogue and both academic achievement and the cognitive abilities. In general, a large number of significantly positive correlations were identified, indicating that students' verbal contributions to classroom dialogue were closely related to their academic scores and cognitive abilities. The higher a student's academic score was, the more and better contributions he/she would make to classroom dialogue; or, to put it differently, talking in classroom dialogue can be a method that facilitates academic achievement.

Table 4.16 Correlation coefficients for the relationship between talk in classroom dialogue and academic achievements (*N*=289)

Participation scales	Mathematics achievement	Physics achievement	English achievement
TISC	.23**	.24**	.16**
TISNC	.20**	.13*	.11
TNISC	.21**	.24**	.18**
TNISNC	.23**	.22**	.16**
Inc	-.06	-.16**	-.18**
Pac	.18**	.20**	.08
Cor	.29**	.32**	.26**
Pri	.19**	.23**	.16**
Per	.08	.06	.06
Gen	.24**	.21**	.18**
Ana	.32**	.36**	.21**
Spe	.27**	.28**	.18**
Upt	.27**	.32**	.23**
Fre	.25**	.26**	.19**

Qua	.27**	.30**	.19**

Note: Inc= Incorrect; Pac= Partially correct; Cor= Correct; Pri= Prior knowledge; Per=Personal information; Gen= Generalization; Ana= Analysis; Spe=Speculation; Upt= Uptake; Fre= Frequency of talk; Sta= Standard level of talk; Cog= Cognitive level of talk; Qua= Quality of talk; *$p < 0.05$, ** $p < 0.01$.

As regards cognitive abilities, quantitative analytical ability was the one that resulted in the largest number of significant correlations with the scales of talk in classroom dialogue. This indicates that students who showed a high level of quantitative analytical ability were more likely to contribute more and better talk; or talking in classroom dialogue fostered the development of students' quantitative analytical ability. Figure analytical ability was significantly related to TISC, TNISC, partially correct, correct, prior knowledge, generalization and analysis. Figure practical ability was significantly associated with TNISC, partially correct, prior knowledge and analysis. Students' talk in classroom dialogue had little or no association with their verbal analytical, verbal practical, verbal creative, quantitative practical, quantitative creative and figure creative abilities. Noticeably, personal experience had little or no correlations with the three academic achievements. Correlation coefficients for the correct and analysis were higher compared to other subcategories, indicating that the accuracy of answers and whether the dialogue showing analysing process had closer relationships with students' achievements.

Table 4.17 Correlation coefficients for the relationship between talk in classroom dialogue and cognitive abilities (*N*=289)

Participation scales	VA	QA	FA	VP	QP	FP	VC	QC	FC
TISC	.09	.19**	.16*	-.05	.08	.12	.01	-.05	.11
TISNC	-.02	.10	.02	.00	-.06	-.09	.00	.03	.03
TNISC	.08	.18**	.15*	.03	.14*	.20*	.08	.06	.11
TNISNC	.08	.09	.03	.02	03	.07	.05	.10	.02
Inc	.06	.08	-.01	-.04	-.01	.00	.00	.06	.08
Pac	.09	.17**	.16**	-.03	.10	.14*	.02	.01	.12
Cor	.05	.21**	.15*	-.01	.09	.10	.00	-.07	.09
Pri	.07	.18**	.14*	-.06	.11	.13*	-.01	-.06	.11
Per	-.02	.03	.10	-.11	-.03	.07	..02	.06	.14
Gen	.09	.17**	.17**	.02	.09	.08	.02	.01	.13
Ana	.07	.24**	.18**	.00	.13*	.17*	.01	-.03	.12
Spe	.05	.21**	.07	-.05	.10	-.01	.02	.02	.09

Upt	.07	.13**	.07	-.03	.12	.10	.02	.08	.12
Fre	.09	.20**	.15*	-.03	.11	.14*	.02	-.01	.11
Qua	.09	.20**	.16*	-.02	.10	.13*	.01	-.04	.13

Note: Inc= Incorrect; Pac= Partially correct; Cor= Correct; Pri= Prior knowledge; Per=Personal information; Gen= Generalization; Ana= Analysis; Spe=Speculation; Upt= Uptake; Fre= Frequency of talk; Sta= Standard level of talk; Cog= Cognitive level of talk; Qua= Quality of talk; QA= Quantitative analytical ability; FA= Figure analytical ability; VP= Verbal practical ability; QP= Quantitative practical ability; FP= Figure practical ability; VC= Verbal creative ability; QC= Quantitative creative ability; FC= Figure creative ability; *$p < 0.05$, ** $p < 0.01$.

Recognition of the function of talk does not mean that listening in classroom dialogue is less important. As seen in Table 4.18, Pearson correlation analyses produced results revealing that frequency of listening was significantly positively related to academic achievement in the three subjects as well as quantitative analytical ability. This indicates that students who listened carefully in classroom dialogue were still capable of learning well. There were no significant relationships between listening experience with scales of learning outcome. Perception of achievement was significantly and negatively related to mathematics achievement.

Table 4.18 Correlation coefficients for the relationship between listening in classroom dialogue and learning outcome (*N*=289)

Learning outcome	Frequency of listening	Listening experience	Perception of achievement
Mathematic achievement	.13*	-.08	-.12*
Physics achievement	.13*	-.07	-.07
English achievement	.15*	.02	-.03
Verbal analytical	.04	-.06	-.01
Quantitative analytical	.13*	-.11	-.01
Figure analytical	.06	-.02	.05
Verbal practical	.00	.01	-.07
Quantitative practical	-.01	.05	-.04
Figure practical	.06	.03	-.01
Verbal creative	.08	-.08	-.09
Quantitative creative	-.01	.10	.11
Figure creative	-.01	.01	-.09

Apart from correlation analyses, I also sought to uncover how learning outcomes could be predicted by participation in classroom dialogue, and thus regression analysis fitted my need. I conducted two series of regression analyses, with the frequency and quality of talk serving as explanatory variables in the first series, and the frequency of listening, listening experience and perception of achievement acting as explanatory variables in the second. Academic achievement and cognitive abilities acted as dependent variables. Besides, gender, school and school class were considered in these regression analyses as controlled variables. Results are shown in Tables 4.19 and 4.20, and I only illustrate the models that had significant values. The quality of talk predicted variations in mathematics, physics and English achievements, and quantitative analytical ability in a positive way. English achievement was also positively predicted by the frequency of talk. Apart from talk, the frequency of listening also had positively predictive power for mathematics and physics learning. As reviewed by Howe and Abedin (2013), many scholars hold the view that classroom dialogue has a positive effect on learning (Christensen & Hansen, 1991; Grouws, 2004; Koichu, Berman, & Moore, 2007). It is considered that the more a student talks, the better he/she will learn, while, on the contrary, students who play a less active role in classroom dialogue, will have a lower level of learning (Dallimore, Julie, & Marjorie, 2010; Nystrand, 1997). My findings partly support their statements - talking more frequently and making higher-quality contributions to classroom dialogue generally positively predict students' learning. This research makes a supplementary finding that listening also contributes to learning, alongside talking. Listening carefully and more frequently in classroom dialogue has also shown a positive prediction for learning outcome, with mathematics and physics at least.

Table 4.19 Predicting learning outcome from talk in classroom dialogue beyond gender, school and school class

	Mathematics score	Physics score	English score	Quantitative analytical
$\beta_{Fretalk}$			.14*	
$\beta_{Quatalk}$	.41**	.39**	.15**	.19**
β_{Gender}	-.19**	-.17**	.24***	-.14*
β_{School}	-.39***	-.66***	-.38**	-.20**
β_{Class}	.48***	.30***	.12*	.21*
R^2_{Total}	0.35	0.46	0.21	0.17
R^2_{talk}	0.05	0.05	0.06	0.16
F	30.40***	48.08***	21.05***	8.34***
Df	5, 281	5, 281	5, 281	5, 281

Note: β = The unique contribution of each component to learning outcomes, in other words, how many standardized deviations a dependent variable will change when per standard deviation increases in the predictor variable; Fretalk = Frequency of talk; Quatalk = Quality of talk; R^2_{Total} = The effectiveness of talking, gender, school and school class in explaining learning outcomes; *Df*= Degree of freedom; * $p < .05$, ** $p < .01$, *** $p < .001$.

Table 4.20 Predicting learning outcome from listening in classroom dialogue beyond gender, school and school class

	Mathematics score	Physics score
$\beta_{Frelistening}$	.11*	.10*
$\beta_{Lisexperi}$	.	
$\beta_{Perachieve}$		
β_{Gender}	-.24**	-.17**
β_{School}	-.41***	-.69***
β_{Class}	.40***	.25***
R^2_{Total}	0.32	0.38
$R^2_{listening}$	0.02	0.02
F	21.67***	33.93***
Df	6, 280	6, 280

Note: β = The unique contribution of each component to learning outcomes, in other words, how many standardized deviations a dependent variable will change when per standard deviation increases in the predictor variable; Lisexperi = Listening experience; Perachieve = Perception of achievement; R^2_{Total} = The effectiveness of gender, school, class and listening in explaining learning outcomes; $R^2_{listening}$ = The effectiveness of listening in classroom dialogue in explaining learning outcome; * $p < .05$, ** $p < .01$, *** $p < .001$.

The main findings of Section 4.4 can be summarized as follows. There was a significant relationship between participation (including talking and listening) in classroom dialogue and learning outcomes. Furthermore, students' learning outcomes can be predicted by their classroom participation. Specifically, mathematical achievement and physics achievement were positively predicted by frequency of talk, quality of talk and frequency of listening. Frequency and quality of talk was predictive for English learning. Quality of talk predicted for quantitative analytical ability.

4.5 Analysis and results of relationship between thinking style and participation in classroom dialogue

In order to investigate how thinking styles correlated with participation in classroom dialogue, namely, the first research question, zero-order correlations were firstly conducted so that the basic relationships between the two constructs could be revealed. In my research design, participation in classroom dialogue took two forms, talk and listening. I conducted Spearman and Pearson correlation analyses of talk and listening respectively. As seen in Table 4.21, in one case, thinking style was significantly related to talk, which supported the conclusions of my MPhil study and responded to the first research

question that the significant relationships found in my MPhil work could be applied to students high school students. In another case, there was also a significant relationship between thinking style and listening. With significant results from both forms, I conclude that thinking style is a factor that is significantly associated with students' participation in classroom dialogue.

The Liberal-Group style showed significant positive relationships with both the frequency and quality of talk, while the Internal-Group style demonstrated negative relationships with the frequency and quality of talk. To be more specific, the Liberal-Group style demonstrated significantly positive relationships with most of the scales: TISC, TNISC, TNISNC, partially correct, correct, prior knowledge, analysis, speculation and up-take. Conversely, the Internal-Group style was identified as having significantly negative relationships with most of the scales: TISC, TNISC, incorrect, partially correct, correct, prior knowledge and analysis. The Conservative-Group style was associated with and significantly reduced dialogue in the forms of correct contributions and generalization. The Global-Group style showed a significantly negative correlation with correct answers.

In terms of the frequency of listening in classroom dialogue, significant correlations emerged for all four groups of styles, with the Liberal, Conservative and Internal Groups showing positive correlations, while the Global-Group style had a negative relationship. As regards listening experience and perception of achievement, significantly positive relationships emerged with the Conservative and Internal Group styles. By contrast, the Liberal-Group style showed a significantly negative relationship with listening experience.

Table 4.21 Correlation coefficients for the relationships between thinking style and participation in classroom dialogue (including talk and listening) (*N*=289)

	Liberal Group style	Conservative Group style	Internal Group style	Global Group style
TISC	.19**	-.06	-.19**	-.07
TISNC	.11	.10	-.09	-.05
TNISC	.17**	-.06	-.19**	-.09
TNISNC	.13*	-.03	-.04	-.09
Inc	.06	-.04	-.12*	-.01
Pac	.19**	.01	-.14*	-.03
Cor	.17**	-.12*	-.17**	-.12*
Pri	.19**	-.06	-.21**	-.09
Per	.02	.01	-.02	-.09
Gen	.11	-.16**	-.06	-.12
Ana	.23**	-.08	-.16**	-.09
Spe	.19**	-.06	-.08	-.03
Upt	.20**	-.04	-.04	-.09
Frt	.20**	-.06	-.20**	-.08
Qut	.20**	-.08	-.17**	-.09
Frl	.12*	.14*	.18**	-.17**
Lie	-.25*	.18**	.20**	.07
Poa	.02	.17**	.14*	-.01

Note: Inc= Incorrect; Pac= Partially correct; Cor= Correct; Pri= Prior knowledge; Per=Personal information; Gen= Generalization; Ana= Analysis; Spe=Speculation; Upt= Uptake; Frt= Frequency of talk; Qut= Quality of talk; Frl= Frequency of listening; Lie= Listening experience; Poa= Perception of achievement; *$p < 0.05$, ** $p < 0.01$.

In order to discover how participation in classroom dialogue can be predicted from thinking style, hierarchical multiple-regression analyses were conducted. As mentioned earlier, the talk data were not normally distributed and thus were not appropriate for linear regression analysis. Transformation of data is commonly used to solve this issue, in which Lg10 is typically useful with left-censored data and heavy-tailed distributions (Manning & Mullahy, 2001). The transformed data will usually demonstrate the shape of normal distributions (Manning & Mullahy, 2001). I thus transformed the frequency and quality of talk using Lg10. It should be noticed that the data used with Lg10 must be numeric and greater than zero. In my database, many students did not make contributions to classroom

dialogue, and thus were recorded as zero under the categories ‘frequency of talk’ and ‘quality of talk’, which did not accord with the premise for using Lg10. In order to address the issue, I added one to each student’s original score and then transformed these new scores using Lg10. The transformed data changed in the same direction as the original data. As seen in Appendix G, the transformed data were normally distributed and could be used for linear regression analysis.

This study aimed to investigate the extent to which thinking style predicted participation in classroom dialogue over and above traditionally studied variables (i.e. gender, school and school class). Thus I conducted hierarchical regression analysis. As shown in Section 4.2, gender, school and school class had exerted significant effects on participation in classroom dialogue, and therefore they needed to be considered in the regression model. To perform the hierarchical regression analysis, gender, school and school class were firstly entered into regression models, followed by the four groups of thinking styles being inserted into the models simultaneously. Frequency of talk (transformed), quality of talk (transformed), frequency of listening, listening experience and perception of achievement were entered into the regression models respectively serving as dependent variables.

Results are shown in Table 4.22. The five models were all significant, indicating thinking style can be used to predict variation in participation in classroom dialogue. As regards talk, students characterized with the Liberal-group style tended to make more and better verbal contributions to classroom dialogue. Conversely, students characterized with the Internal Group style tended to remain silent in class. In terms of listening, students featured by the Internal-Group style were more likely to pay attention to course content without becoming distracted, while students characterized with the Global Group style listened less frequently in classroom dialogue. Students characterized with the Conservative and Internal Group styles were more likely to feel comfortable to remain attentive silent in class and found listening to others more effective in terms of learning. Conversely, students dominated by the Liberal-Group style tended to have worse learning experiences through listening in classroom dialogue.

Table 4.22 Predicting participation in classroom dialogue from clustered thinking styles beyond gender, school and school class

	Frequency of talk	Quality of talk	Frequency of listening	Listening experience	Perception of achievement
$\beta_{\text{Liberal-group}}$	.19**	.19**		-.32***	
$\beta_{\text{Conservative-group}}$				.26***	.19**
$\beta_{\text{Internal-group}}$	-.25***	-.23***	.14*	.21***	.12*
$\beta_{\text{Global-group}}$			-.13*		
β_{Gender}	-.15**	-.14**	.22***		
β_{School}			-.22**		.16*
β_{Class}			.14*		-.15*
R^2_{Total}	0.14	0.13	0.17	0.17	0.08
R^2_{Style}	0.10	0.10	0.06	0.16	0.05
F	6.61***	5.30***	7.96***	8.34***	3.66**
Df	7, 279	7, 279	7, 279	7, 279	7, 279

Note: β = The unique contribution of each component to participation in classroom dialogue, in other words, how many standardized deviations a dependent variable will change when per standard deviation increases in the predictor variable; R^2_{Total} = The effectiveness of gender, school, school class and thinking styles in explaining varied participation behaviours; R^2_{style} = The effectiveness of thinking styles in explaining participation behaviours; * $p < .05$, ** $p < .01$, *** $p < .001$.

To summarize, thinking style was significantly correlated with and can be used to predict participation in classroom dialogue, including both talk and listening. The Liberal-Group style positively predicted both the frequency and quality of talk, while the Internal-Group style negatively predicted these. Moreover, the Internal-Group style was positively predictive for the frequency of listening. Listening experience and perception of achievement were positively predicted by the Conservative-Group and the Internal-Group styles. The Liberal-Group style was significantly and negatively predictive for listening experience.

4.6 Analysis and results of relationships between thinking styles and learning outcomes

I conducted a series of Pearson correlation analyses, relating the clustered thinking styles to academic achievement and cognitive abilities. As shown in Table 4.23, most of correlation coefficients were below .10, which is very low. No significant results were produced concerning the relationship between thinking styles and academic achievement. As regards relations between thinking styles and cognitive abilities, most of the correlation coefficients were again very small and not significant. The only exception was a significantly negative relationship between the Conservative Group style and

quantitative practical ability, which may be significant by chance (given the number of comparisons). In general, this finding is in alignment with Sternberg's (1997) statement that thinking style is not something related to ability, but is concerned mainly with suitability and fitness.

Table 4.23 Correlation coefficients for the relationship between thinking style and learning outcome (*N*=289)

	Liberal Group style	Conservative Group style	Internal Group style	Global Group style
MA	.06	-.06	.09	-.02
PA	.08	-.03	.11	.04
EA	-.04	-.02	-.07	-.08
VA	.04	-.04	.05	.05
QA	.11	-.07	.07	-.10
FA	.03	-.04	.02	-.05
VP	-.10	-.03	.03	.10
QP	-.07	-.13*	.08	.06
FP	-.02	-.12	-.01	.01
VC	-.04	-.11	.11	.07
QC	-.03	.09	-.06	.08
FC	-.07	-.03	.05	.06

Note: *$p < 0.05$; MA= Mathematic achievement, PA= Physics achievement, EA= English achievement, VA= Verbal analytical ability, QA= Quantitative analytical ability, FA= Figure analytical ability, VP= Verbal practical ability, QP= Quantitative practical ability, FP= Figure practical ability, VC= Verbal creative ability, QC= Quantitative creative ability, FC= Figure creative ability.

Section 4.6 can be summarized as showing that no or little relationship was found between thinking style and learning outcome, including academic achievement and cognitive ability.

4.7 Analysis and results of relationship between thinking style, participation in classroom dialogue and learning outcomes

With acknowledgement of the relationships between each of the two variables, next comes an exploration of the relationship between all three. In particular, I intended to test whether thinking style moderates the relationship between participation in classroom dialogue and learning outcome. As stated by Berger (2015), there are several steps to conducting moderation analyses. The first step involves centering the explanatory variables. According to Donaldson (2001), when predictor variables overlap substantially, that is they are highly multicollinear, the results produced by regression analysis will not be stable and reliable. Cohen, Cohen, West, and Aiken (2003, p. 267) recommend that

continuous predictor variables be centered before interaction terms are computed, unless the variable has a meaningful zero. Thus predictors need to be centered to a mean of zero to reduce overlap between explanatory variables. I centered thinking styles and participation (i.e. frequency of talk, quality of talk, frequency of listening, listening experience and perception of achievement) by clicking "save standardized values as variables" in SPSS. I then created interaction terms by multiplying the centered thinking styles and centered participation variables. With two continuous predictors, the interaction term is computed as the product of thinking style and participation, and it is tested as the contribution of the interaction term beyond the main effects in predicting the learning outcome. Readers should pay special attention to the interaction term, which indicates for moderation effect when it is statistically significant. Next came a series of multiple regression analyses, with scales of participation in classroom dialogue entered into the model in the first step, scales of thinking styles entered in the second and the corresponding interaction term entered in the third. This sequence of entering allowed me to see whether the addition of an interaction term improved the prediction of learning outcome. Notably, the focus in this study is on thinking style, and testing its effect on the relationship between participation and learning outcome is the main purpose. Thus other interference factors, namely gender, school and class, could act as standard errors in the models (Hayes, 2013).

Table 4.24 Moderation of thinking style's effect on classroom participation in predicting mathematics achievement (*N*=289)

Variable	R^2 change	B	SE	Beta
Frequency of talk	.07***	.45	.11	.25***
Liberal Group	.00	-.15	1.29	-.01
Fretalk_x_Liberal	.01	.62	1.15	.03
Constant		92.07	1.80	
Frequency of talk	.06***	.42	.11	.23***
Conservative Group	.01	-.89	1.25	-.04
Fretalk_x_Conservative	.01	-1.95	1.24	-.09
Constant		92.38	1.78	
Frequency of talk	.07***	.52	.11	.29***
Internal Group	.02**	3.32	1.28	.15**
Fretalk_x_Internal	.01	-.53	1.27	-.03
Constant		91.23	1.78	
Frequency of talk	.07***	.45	.10	.25***
Global Group	.00	.14	1.26	.01
Fretalk_x_Global	.00	-1.11	1.21	-.05
Constant		92.03	1.77	
Quality of talk	.00	.06	.14	.05
Liberal Group	.05	6.90	3.83	.25
Quatalk_x_Liberal	.12*	9.12	3.60	.35**
Constant		71.69	4.67	
Quality of talk	.00	-.16	.16	-.15
Internal Group	.01	-4.69	3.52	-.19
Quatalk_x_Internal	.11*	-11.65	4.95	-.36*
Constant		74.29	4.81	
Frequency of listening	.01	1.03	7.52	.02
Liberal Group	.05	-4.83	3.98	-.17
Frelist_x_Liberal	.08*	-8.36	4.09	-.29*
Constant		68.60	28.92	

Variable	R^2 change	B	SE	Beta
Listening experience	.01	-2.04	1.53	-.01
Global Group	.01	-0.31	1.28	-.08
Lisexper_x_Global	.02*	2.62	1.17	.13*
Constant		103.86	5.65	
Perception of achievement	.14*	-2.84	1.41	-.12*
Liberal Group	.01	1.32	1.28	.06
Perachi x Liberal	.01	0.23	1.19	.01
Constant		106.11	4.41	
Perception of achievement	.02*	-3.21	1.41	-.13*
Internal Group	.01	2.10	1.29	.10
Perachi x Internal	.01	1.94	1.25	.09
Constant		106.97	4.38	

Note: *p< .05, **p < .01, ***p < .001. Fretalk = Frequency of talk; Quatalk = Quality of talk; Frelist= Frequency of listening; Lisexer = Listening experience; Perachi = Perception of achievement; x = Multipling by the centered two variables.

Table 4.25 Moderation of thinking style's effect on classroom participation in predicting physics achievement(*N*=289)

Variable	R^2 change	B	SE	Beta
Frequency of talk	.09***	.39	.08	.31***
Liberal Group	.00	.05	.89	.01
Fretalk_x_Liberal	.00	-.39	.80	-.03
Constant		55.74	1.24	
Frequency of talk	.09***	.37	.07	.30***
Conservative Group	.00	.01	.87	-.00
Fretalk_x_Conservative	.00	-.14	.86	.01
Constant		55.80	1.23	

Variable	R^2 change	B	SE	Beta
Frequency of talk	.09***	.42	.08	.33***
Internal Group	.04**	2.86	.87	.19**
Fretalk_x_Internal	.01	-.70	.87	-.05
Constant		55.14	1.21	
Frequency of talk	.09***	.38	.08	.31**
Global Group	.01	1.10	.87	.07
Fretalk_x_Global	.00	-.15	.84	-.01
Constant		55.68	1.22	
Quality of talk	.18**	.31	.09	.47**
Liberal Group	.07*	-4.92	2.28	-.28*
Quatalk_x_Liberal	.02	-2.43	2.15	-.15
Constant		36.53	2.78	
Quality of talk	.18**	.24	.09	.36*
Internal Group	.02	1.31	2.06	.09
Quatalk_x_Internal	.05	-5.16	2.90	-.25
Constant		37.54	2.82	
Quality of talk	.18**	.32	.13	.49*
Global Group	.01	2.33	3.11	.10
Quatalk_x_Global	.00	.96	3.58	.05
Constant		36.63	3.24	
Frequency of listening	.03	4.47	4.69	.13
Liberal Group	.06*	-3.21	2.48	-.18
Frelist_x_Liberal	.08*	-5.33	2.55	-.29*
Constant		26.24	18.04	
Perception of achievement	.01	-1.51	.99	-.09
Internal Group	.02*	1.86	.90	.12*
Perachi_x_Internal	.01	0.54	.88	.04
Constant		64.78	3.08	

Note:*p< .05, **p < .01, ***p < .001. Fretalk = Frequency of talk; Quatalk = Quality of talk; Frelist= Frequency of listening; Perachi = Perception of achievement; x = Multipling by the centered two variables.

Table 4.26 Moderation of thinking style's effect on classroom participation in predicting English achievement(*N*=289)

Variable	R^2 change	B	SE	Beta
Frequency of talk	.03**	.32	.09	.23**
Liberal Group	.01	-1.44	.03	-.08
Fretalk_x_Liberal	.01	-1.55	.92	-.10
Constant		96.37	1.43	
Frequency of talk	.03**	.26	.26	.18**
Conservative Group	.00	-.05	-.05	-.00
Fretalk_x_Conservative	.00	.93	.93	.06
Constant		96.80	96.80	
Frequency of talk	.03**	.26	.09	.18**
Internal Group	.00	-.48	1.03	-.03
Fretalk_x_Internal	.01	1.11	1.03	.07
Constant		96.98	1.44	
Frequency of talk	.03**	.24	.08	.17**
Global Group	.01	-1.25	1.01	-.07
Fretalk_x_Global	.00	.77	.97	.05
Constant		97.03	1.42	

Note: *p< .05, **p < .01, ***p < .001. Fretalk = Frequency of talk; Quatalk = Quality of talk; Frelist= Frequency of listening; Qualist = Quality of listening; x = Multipling by the centered two variables.

Table 4.27 Moderation of thinking style's effect on classroom participation in predicting quantitative analytical ability (*N*=289)

Variable	R^2 change	B	SE	Beta
Frequency of talk	.05***	.02	.01	.22***
Liberal Group	.00	.00	.07	.00
Fretalk_x_Liberal	.00	-.02	.06	-.02
Constant		2.74	.09	

Variable	R^2 change	B	SE	Beta
Frequency of talk	.05***	.02	.01	.20***
Conservative Group	.01	-.06	.06	-.05
Fretalk_x_Conservative	.01	-.06	.06	-.06
Constant		2.76	.09	
Frequency of talk	.05***	.02	.01	.22**
Internal Group	.00	-.00	.07	-.00
Fretalk_x_Internal	.00	-.01	.06	-.01
Constant		2.75	.09	
Frequency of talk	.05***	.02	.01	.21***
Global Group	.00	-.03	.06	-.03
Fretalk_x_Global	.00	-.06	.06	-.05
Constant		2.75	.09	

Note: *p< .05, **p < .01, ***p < .001. Fretalk = Frequency of talk; Quatalk = Quality of talk; Frelist= Frequency of listening; Qualist = Quality of listening; x = Multipling by the centered two variables.

Results are shown in Tables 4.24, 4.25, 4.26 and 4.27 respectively. As indicated in these four tables, talking was a strong predictor of academic achievements and analytical ability, regardless of the type of thinking style that characterized a student. This confirms the results reported in Section 4.6. Frequency of listening, listening experience and perception of achievement played a relative small role in explaining the variations in academic achievement, especially in English, and cognitive ability.

More importantly, the results generally support my hypothesis that thinking style moderated the relationship between participation in classroom dialogue and learning outcome, at least in mathematics and physics. As regards results shown on Table 4.24, in the fifth model, the Beta value for the interaction term is significantly positive, indicating that the Liberal-Group style moderates the relationship between quality of talk and mathematical achievement. This suggests that for students with a higher tendency to the Liberal-group style, the higher the quality of talk they contributed, the more likely they were to achieve well in mathematics. In the sixth model the Beta value for the interaction term is significantly negative, indicating that the Internal-Group style moderated the relationship between the quality of talk and mathematics achievement. Students characterized with the Internal-Group style were less likely to achieve good mathematic scores when they contributed a higher level of talk. In the seventh model, the Beta weight for the interaction term is significantly negative, which means that for students who had a higher tendency to the Liberal-Group style, the more they listened in classroom dialogue, the less likely they were to attain good mathematics scores.

In the eighth model, the Beta weight for the interaction term multiplied by listening experience and Global-Group style was significantly positive, indicating that a higher tendency towards the Global-Group style would increase mathematics scores when students perceived to have a comfortable listening experience. Regarding the results shown in Table 4.25, in the eighth model, the interaction term created by frequency of listening and the Liberal-Group style produced a significant and negative Beta value. This indicates that the Liberal-Group style tended to result in adverse effects on the relationship between frequency of listening and physics achievement.

To summarize, this section confirms the findings achieved in Section 4.4 that talk in classroom dialogue is a strong predictor for learning outcomes. More importantly, this section supports the hypothesis that thinking style significantly affects the relationship between participation in classroom dialogue and learning outcomes.

4.8 Results of the qualitative analyses

In order to address the fifth research question, I conducted a qualitative analysis to understand how students viewed the effect of thinking style on the relationship between classroom participation and learning outcome. The qualitative data enabled me to develop a deeper understanding of quantitative results. Three interview questions were used to invite students' opinions: 1. Why did you talk actively or remain silent in classroom dialogue? 2. Do you find it related to your personal characteristics and thinking styles? 3. Do you find it helps or hinders your learning? In reality, answers to Questions 2 and 3 were often given when the students responded to Question 1. Likewise I could often get some clues as to what students thought about Questions 2 and 3 from their answers to Question 1. Students had a rather limited understanding of thinking style, as it is quite a new concept to Chinese students. I thus explained to them what thinking style is and gave them specific examples before they responded to Question 2. Given that I based my study on the style construct proposed by Sternberg, the concept of thinking styles was presented in accordance with his ways. In particular, the metaphor 'government' helped a great deal for students to make sense of thinking styles. Then I gave them five specific style examples. There are five dimensions of styles within Sternberg's construct and I introduced one style within each dimension to students. For example, within level dimension, global style was selected as an example, 'People characterized with the global style tend to make plans before they start to work on a task and like to view things as a whole, while sometimes easily overlooking details'.

Students were interviewed individually, each interview lasting around half an hour. All 12 interviews were tape-recorded after receiving the students' permission. The gender and academic achievement of the 12 interviewees are listed in Table 4.28. There were similar, although not identical,

numbers of male and female interviewees. The academic achievements of the interviewees covered a wide spectrum, ranging from a high score 118 to a low score 55. The outcomes of the qualitative analyses provided detailed illustrations and enriched understanding of the quantitative data.

Table 4.28 Identities of interviewees

School	Interviewee	Gender	Mathematics achievement	English achievement	Physics achievement
No. 1 Middle school	IT1 (S)	Male	110	102	70
	IT2 (T)	Female	95	109	65
	IT3 (S)	Female	87	83	55
	IT4 (T)	Female	93	99	62
No. 2 Middle School	IT5 (S)	Female	115	116	80
	IT6 (T)	Male	118	105	90
	IT7 (S)	Male	96	98	67
	IT8 (T)	Female	87	95	60
No. 3 School	IT9 (S)	Female	80	83	56
	IT10 (T)	Male	117	104	80
	IT11 (S)	Male	99	105	78
	IT12 (T)	Female	97	94	61

Note: S = Students relatively silent; T = Students relatively talkative.

I conducted thematic analysis on the interview data. Thematic analysis is "a method for identifying, analysing and reporting patterns (themes) within data" (Braun & Clarke, 2006, p.79). The reason for its adoption is that the method can generate unanticipated insights and usefully summarize key features of a large body of data (Braun & Clarke, 2006). As regards my study, it was expected that interviews would supplement the quantitative approach, particularly by enabling the development of a deep understanding of the three aspects of the interview questions. Thus thematic analysis was deemed appropriate and convenient for use.

According to Braun and Clarke (2006), five main steps are generally used in conducting thematic analyses. The first step is to transcribe audio-recordings into written form (Gibson, 2010). Transcription is "a matter of selectively deciding on which aspects of a given dataset are relevant (…) and involves re-presenting some feature of the data in a way that enables the researcher to do some analytic work with it" (Gibson, 2010, p. 297). I interviewed students in Chinese, as it was the mother language of these high school students, and it was of course much easier for them to speak fluently in

Chinese than English. The transcripts thus were in Chinese. The process of transcription allowed me to familiarize myself with the data by reading, re-reading and noting down initial ideas.

Secondly, I generated initial codes from the raw data, which was a way of organizing information and identifying what was useful in the context of my research. I worked directly on the Chinese transcripts without translating them into English at this stage. This retained the information from the verbal account in a way which was true to its original nature, without the risk of missing important information. As described above, the selection of talkative and relatively silent students was based on the results of quantitative analysis. I counted the number of times that each individual contributed o classroom dialogue. Students who contributed a great number of talk were viewed as talkative participants, while those made a limited number of contributions were rated as relatively silent. Transcripts of talkative and quiet interviewees were coded separately first, and then I compared commonalities and differences in the codes between the two groups of students. The codes were derived on the basis of my research interests; namely, the three interview questions. Content showing reasons for students' different participatory behaviours, relevance to individual differences and relevance to learning outcomes were given precedence. It is notable that I tried to identify whether students' descriptions showed the attributes of the 13 thinking styles proposed by Sternberg when coding transcripts in response to the second question. For all the interview questions the codes demonstrated in the transcripts of talkative and silent students shared a high proportion of commonalities. The codes identified in the transcripts of the three questions are listed in the first columns of Tables 7.1, 7.2 and 7.3 respectively in Appendix H.

Thirdly, I searched for basic themes by sorting the codes on the basis of conceptual correspondence. The basic themes differ from the codes and are often broader and represent a level of patterned response or meaning (Saldana, 2009). I went through codes and their corresponding text segments several times in order to ensure that the developed themes were discrete (not repetitive) and broad enough to encapsulate the meanings of a set of codes. As can be seen in Tables 7.1, 7.2 and 7.3, the basic themes were listed in the second column and each was developed based on the earlier codes. For instance, the basic theme 'understanding' was deduced from the codes 'know limits', 'clarify thoughts', understand deeply', 'clear', 'correct answers', 'structured' and 'organized'. In response to the first interview questions, the codes were clustered into nine basic themes: 'keeping up with the lesson', 'understanding', 'reasoning', 'memorization', 'getting access to diverse ideas', 'capability', 'preference', 'responsibility' and 'learning context'. With respect to the second question, I tried to collapse the codes into the 13 thinking styles proposed by Sternberg (1997). Thirteen basic themes were produced. There was one theme named as 'style', which indicated that style difference was likely to have connections with students' varied participation; 11 basics themes were named after Sternberg's

thinking styles, which means that 11 out of the 13 thinking styles proposed by Sternberg could be identified in the codes; the last basic theme was named as ‘other styles’, and this was to house the codes which could demonstrate styles, but not those in Sternberg’s model. Regarding the third question, seven basic themes were generated; namely, ‘self-regulation’, keeping up with the lesson’, ‘understanding knowledge better’, ‘thinking critically’, ‘memorization’, ‘showing in examination’ and ‘effects depend’.

The fourth step was to refine the basic themes and to check if there was a possibility of developing organized themes. Organized themes were deduced from basic themes, and they enabled the researchers to uncover the underlying issues shared between the basic themes. Three organized themes were deduced in response to the first question - why do students talk or listen in classroom dialogue? The students indicated that choosing to talk or listen was for the purpose of ‘keeping up with the lesson’, ‘understanding’, ‘reasoning’, ‘memorization’ or ‘getting access to diverse ideas’. These are different aspects of learning goals, and by unifying the basic themes I obtained the first organized theme of ‘motivation to learn well makes students either talk or listen’. Moreover, students were aware of personal characteristics in their ‘capability’ to figure out an answer and ‘preference’ for a particular method of learning. These two basic themes reflected a common issue that ‘individual differences play a role in making students either talk or listen’, and some students showed ‘a sense of self-awareness and tended to self-regulate their learning’. This emerged as the second organized theme. Finally, students, especially high attaining students, were aware that they were expected to take ‘responsibility’ and contribute to classroom talk. Also, the ‘whole-class learning context’ featured large numbers of students, and limited chances to talk were reported as a reason for making students either talking or listening. These two basic themes reflect an organized theme; namely, ‘context influences of’. Regarding the second question, I collapsed codes into the thinking styles proposed by Sternberg, which are abstract and refined. Thus, I did not unify them to produce an organized theme. With respect to the transcripts in response to the third question, three organized themes were deduced. The interviewees used a high proportion of active sentences in their expressions (I believe so, I can, I think so), which implied that some students chose to involve in dialogue through their preferred ways, and they were optimistic about the learning outcomes achieved through their particular choices. A theme generated was that ‘some students show self-awareness and tend to regulate their learning’. Also, students reported that a particular participatory behaviour (talking or listening) had helped them with ‘keeping up with the lesson’, ‘understanding knowledge better’, ‘thinking critically’, ‘memorization’ and ‘enhancing academic scores’. The deduction of these basic themes produced an organized theme; namely, ‘most students perceived that they learnt well when they participated in dialogue in their

preferred ways.' In comparison, 'effects depend' was developed to describe students who were unsure about the influence of participation on their learning outcomes.

In the fifth step, by referring back to the research questions I produced a report (see below) explaining why the students involved themselves in dialogue in a particular way, how students' thinking styles were seen to affect their participation, and how they regarded themselves as benefiting from participating in a particular way. Relevant information, including codes and themes, were translated into English at this stage. Thematic maps demonstrating how themes were developed from codes can be seen in Appendix H.

4.8.1 Reasons for students' talk or silence

The students gave several different reasons for active talking in class. One essential reason was that asking and answering helped students maintain concentration and focus on course content. This was mentioned by all interviewees as being a motive for their talk. A few examples include: *"When I participate in class, I can keep up with the rhythm of lessons", "My mind used to wander around in class, and then my teacher told me answering questions might be a good help. And I tried. Now it really works", "Speaking in class make me focus on what the teacher said and asked. It makes me to use class time more efficiently."* The second explanation frequently cited was that talk facilitated understanding and reasoning. Five out of the six highly talkative interviewees viewed it as a reason for talk. *"It helps me clarify my thought", "I will know which part of knowledge has already been mastered, which part is not that familiar to me or that clear", "When you talk, the teacher will correct you if you make a mistake, it helps you understand the problem more deeply."* Next came the reason that talk helped the students memorize knowledge better. *"When I answer a question in front of the class, I can always remember it more clearly. Even though I made a mistake or contributed an incorrect answer, it turned out to be more impressive*". Two interviewees mentioned another reason: involvement in classroom talk allowed them to gain access to diverse ideas and opinion, and new methods to solve problems. Lastly, one student indicated that his good academic scores in particular subjects gave him confidence and made him feel that he should respond actively to teachers' questions.

Several main reasons for students' preference for listening emerged when I transcribed the audiotapes from the six relatively silent students. Needing time to take notes was the reason that was mentioned by most of the interviewees who chose to remain silent in class. *"Teachers usually leave us very limited time, and I want to take notes first, so that I can review after class", "If I talked or answered a question, I would have no time to take notes"* Four out of the six students preferred to listen to others during classroom dialogue as they found silence enabled them to understand more deeply and solve problems more critically. *"If I think about a problem by myself quietly, my mind is*

clearer and more structured", "I need more time to reflect on what the teacher said, and if I am allowed to do so, I usually understand the problems better". An interviewee explained particularly well how listening in classroom dialogue helped with advanced thinking: "*You see, when a teacher teaches us how to solve a mathematical problem, she usually divides the whole problem-solving into several steps…and usually asks questions for each step. If you just answer questions immediately after the teacher raised a question, which some of my classmates do, you will lose a precious opportunity to think of the problem as a whole, to think how to generalize the method to similar problems*". Next came needing time for memorization, which was viewed by four students as hindering their talk. *"I'm not talking, but I am not absent-minded, I just use the time to memorize knowledge".* Two interviewees regarded the difficulty of questions as hindering their talk, and they did not know or were unsure of their answers. Lastly, lack of confidence was mentioned by an interviewee and she was afraid her classmates would "*make jokes*".

Two main findings are indicated by the above responses. Firstly, I noticed that both talkative and silent interviewees regarded improving understanding, facilitating memorization and making good use of class time as reasons for their particular approach to classroom dialogue. Similar motives led to different approaches, suggesting that it might be students' individual characteristics over and above their motives that affected whether they talked in class. The second finding was that the students generally had quite strong self-awareness and they know well which approach to participation would lead to better achievement. None of them reported following teachers' instructions as a reason for their talk or silence. This indicates that the students generally had a sound sense of mastery over their learning and saw themselves as allowed to learn in their preferred ways, rather than being influenced or impelled by their teachers to talk or not.

4.8.2 Thinking styles affecting students' classroom performance

The second interview question was "Do you find it related to your personal characteristics," to which all interviewees answered "*yes*". I then asked a follow-up question: "How has your preference for talk/listening been influenced by your personal characteristics? Is it related to your thinking styles?" From responses to the follow-up question, I found that the students generally had a rather limited understanding of thinking styles, and few of them used the particular term "thinking style" in their descriptions. Nevertheless, it was still possible to discern from the students' opinions evidence of thinking styles being seen to affect their patterns of participation. For example, one talkative student said that *"I like to keep up with teachers in class and answer teachers' questions. This is because I think the teacher is more experienced"*. This view shows characteristics of an executive style. Another student played an active role in classroom talk because he attributed it to his preference to *"sharing ideas with others, which can always give me some new inspirations"*, which embodied the

characteristics of an external style. Two talkative students believed the speed of processing information made them capable of talk: *"I usually process information faster than my classmates… I can reflect on teachers' delivery quickly, and then come up with an answer" "because I can think fast, and it will not conflict with taking notes".* This showed the characteristics of a liberal style.

As regards interviewees who tended to remain silent in class, three examples illustrated how their thinking styles was seen as taking an effect. One student said, *"My mind is rather fixed, or stubborn, I would say, haha… It is rather hard to change… I need time to understand new knowledge*", which made her less likely to talk in class. This view can be related to the characteristics of a Conservative style. Another student remained silent in class because "*I prefer to think by myself. I took notes using some codes that are unique to myself",* which displays the feature of an Internal style. The third example came from a girl saying, "*I like to look at a problem as a whole firstly, and compare it with other problems, umm… to see what are their similarities and differences…It's more useful for my learning than answering teachers' non-nutritious questions*". It is the Global style's characteristics that are shown in her descriptions.

To summarize, although not mentioning thinking style directly, interviewees' expressions showed signs of how thinking styles influenced their participation in classroom dialogue. Moreover, the interviews supported my quantitative results: for example, the positive relationship between the Liberal-Group style and talk in classroom dialogue, and the negative relationships between the Internal Group style and frequency of talk.

4.8.3 Influence on learning outcomes

Regardless of students' real academic scores, both talkative and silent interviewees considered their particular performance in classroom dialogue helped with their learning. Eight out of the 12 interviewees gave a positive response to the third question - *"Yes, it is good for my learning*". Three interviewees reported responded hesitantly: "*I guess so…"* Only one of the 12 was unsure whether participation influenced academic achievement. *"I am not sure, answering questions actively might be good, because teachers said so."*

When answering the follow-up question, "how talk/silence benefits learning", keeping up with teachers, increasing understanding, training reasoning and helping with memorization were noted by interviewees as beneficial results of particular choices of classroom participation. Both talkative and silent students mentioned the above four points in their descriptions, in which the first – keeping up with teachers - was mentioned by most interviewees. It can be seen from the four points that interviewees' particular choice of classroom participation was seen not only to help students keep up with teachers and memorization basic knowledge, but also to facilitate understanding and reasoning.

It is notable that these answers were similar to responses to Question 1. This indicates that the interviewees' choice of either talk or silence was made from the motive to learn well. In the students' opinion, both talk and silence were likely to promote a student's learning as long as the method suited his/her personal characteristics.

Chapter 5 Discussion

The purpose of this study is to investigate the relationships between thinking styles, participation in classroom dialogue and learning outcome. Here, the results, indicated by the data relating to thinking styles, talk and listening in classroom dialogue and learning outcomes, are first discussed separately. Next, the findings concerning the relationships between each pair of the three variables are analyzed, in response to the first three research questions. Special attention is paid to the characteristics of high school students and comparing the findings with those targeting younger students. In response to the fourth research question, an explanation is offered of why thinking style can sometimes be a factor that moderates the relationship between classroom participation and learning outcomes. Additionally, there is an attempt to understand the implications of the student interview discussions.

5.1 Thinking style

TSI-RII is the second version of a tool proposed by Sternberg and designed to measure thinking styles. Since it came out in 2007, the measurement tool has been used in a variety of studies to collect data on the thinking styles of Chinese students, and testing has found it to be reliable and valid. Notably, almost all studies using TSI-RII have been conducted with university students, while hardly any have been carried out with school students, in particular those aged 17-19 years. This study tested TSI-RII with high school students with the aim of examining whether the measurement tool could be employed to measure their thinking styles convincingly and reliably. The results showed that the Cronbach's alpha for the anarchic thinking style was low (.55), indicating its low internal reliability, as earlier identified in my MPhil study and some other scholars (e.g. Fan et al., 2010; Zhang, 2004). The other 12 thinking styles showed satisfactory internal consistencies, with all Cronbach's alphas above .60. Notably, the internal consistency of the monarchic style improved compared with that reported in the earlier MPhil study when TSI-RII was used with secondary school students. This revealed that, in general, TRI-RII is a reliable tool for measuring high school students' thinking styles, except for the items relating to the anarchic style.

There are three possible explanations for the above findings. One may be the characteristics of the sample selected for addressing the research questions, namely high school students. With an average age of 18 years, the participants probably had better self-awareness and self-understanding than secondary school students, yet were arguably not as mature as university students. Moreover, many high school students in China tend to study according to their teachers' instructions and possibly do not self-reflect optimally on their personal characteristics, including their thinking styles. This implies that the responses of some participants may not fully reflect their thinking styles.

The other possible explanation may relate to the descriptions of particular items in TSI-RII. It was claimed by Coffield et al. (2004) that the items in the two previous versions of TSI-RII were generalized and concrete, requiring students to have relatively high levels of self-awareness and understanding in their typical ways of thinking. The latest version, TSI-RII, has made an effort to modify its expressions, yet some items remain rather unintelligible and vague for high school students. An example is: "Usually when I make a decision, I do not pay much attention to details". Students may have been confused by this, wondering, what type of decision is being made? Is it a small, everyday decision, such as what to have for lunch? Or an important decision, such as what to study at university? Without proper restrictions on the scenario, participants may have felt confused in response to the questionnaire, and a few participants did report this problem.

Moreover, some situations mentioned in the questionnaire are less likely to be met by Chinese students. For instance, an item used to measure the anarchic style was: "When working on a written project, I usually let my mind wander and my pen follow up on whatever thoughts cross my mind". It was almost impossible for the research participants to experience this in real life, as written projects in Chinese high schools have very strict requirements for structure, grammar, expression and thoughts. TSI-RII was originally designed to measure the thinking styles of American students, and the situations described in its items are based on Americans' daily experiences. Thus, when translated and used with Chinese students, some descriptions may have turned out to be unsuitable and not acclimatized to the Chinese context. To improve the internal reliability of the TSI-RII, a reasonable approach would be to add more specific descriptions or situational contexts. Particular cases and descriptions may need to be adjusted to meet the social context in the Chinese version.

Regarding the descriptive statistics on thinking style, the mean for legislative style ranked top. This was identical to that reported in the MPhil study when secondary school students served as participants, and it has also been reported in some recent studies focusing on university students (e.g. Fan et al., 2010). The indication from this finding is that many Chinese students, including those in schools and universities, have quite a strong preference to think and work independently. They tend to decide for themselves what to learn and how to learn, rather than being passive recipients of a collection of facts and concepts. In comparison, studies published in the 20th century often depicted Chinese students as merely repeating views from textbooks and depending on their teachers' instructions, while lacking their own thoughts (e.g. Biggs, 1996; Chan & Watkin, 1994). As noted in Section 2.2.2, a positive change took place several years ago through the implementation of "character building education" reform. The reform aimed to stimulate students to think independently, and to increase their motivation and initiative in learning. The high mean for legislative style may reflect the

fact that Chinese learners have been influenced by this move. This also demonstrates the impact of environment on shifts of styles and indicates that styles are malleable.

Gender was found to be significantly correlated with thinking styles. Male students were more liberal and internal than their female counterparts, while girls were more likely to be characterized with hierarchical styles than boys. The differences between boys and girls in their thinking styles have also been identified by many other studies (e.g. Fan & Zhang, 2014; Zhang, 2004; Zhang & Postiglione, 2001). In Zhang (2004), with male students consistently more likely to prefer liberal styles than female students. Fan and Zhang (2014) found that males scored significantly higher on the liberal (F = 24.34, p <.001) and internal (F = 9.14, p <.01) styles than females. This indicates that boys tend to come up with more new and creative ideas, and be more adaptive to new methods and the environment. At the same time, boys seem more likely to prefer thinking and studying alone than girls. Female learners have emerged as superior to their male counterparts in terms of rational thinking and were more organized when it comes to coping with multiple tasks. With regard to differences between schools and school classes, few previous studies have tested these in relation to thinking styles, probably because university students were their focus. In the case of high school students in China, it is necessary to consider the influence of schools and classes, as they are closely related to students' school life and learning. The results of this study showed no significant differences in thinking styles between students in various schools and classes. Even though participants were selected from diverse levels of schooling, students tended to have similar preferences in their ways of thinking and processing information.

In order to reduce multicollinearity, a factor analysis was conducted which produced four clusters of styles, named the Liberal-Group style, Conservative-Group style, Internal-Group style and the Global-Group style. The Liberal Group was dominated by the liberal, legislative, judicial and hierarchical styles. The conservative, executive, monarchic and oligarchic styles had high loadings with the Conservative Group. The Internal Group style was characterized by a highly positive loading of internal style and a highly negative loading of external style. The Global Group was associated positively with the global style and negatively with local style. This clustering of styles is reasonable as it generally corresponds to the Type I, Type II, Type III style constructs proposed by Zhang and Sternberg (2005). Thinking styles showing the attributes of cognitive-complexity and low level of conformity, namely, Type I styles, were highly loaded on the Legislative Group; styles embodying the attributes of cognitive-simplicity and norm-favouring are highly loaded on the Conservative Group; thinking styles from Type III style family dominated the Internal Group. A discrepancy in the style construct of Zhang and Sternberg (2005) is that global style, belonging to the Type I family, and local style, belong to the Type II family, were clustered as one factor in my study. This has been reported a

number of times in previously published studies. The thinking styles have been clustered into three, four or five factors (see e.g. Zhang, 2001, 2004). This study also produced a four-factor model, which is identical to that produced in some other studies, for instance, Zhang's study of 215 students from mainland China (2001), and the global and local styles were highly loaded on one factor. Therefore, the clustering of styles identified in this study makes sense and can reflect the characteristics of the thinking styles of high-school Chinese learners.

5.2 Participation in classroom dialogue

5.2.1 Talk in classroom dialogue

Participation in classroom dialogue, as an essential method for increasing involvement in classroom teaching, has been heavily studied during the past 40 years. Yet the focus has been on primary and secondary school students, while very few studies have investigated how high school students, specially those aged 17-19 years, perform in classroom talk. Moreover, there have been relatively few studies selecting Chinese students as the research participants. In the few studies with a Chinese focus, learners have often been portrayed in a stereotypical way as less talkative, reluctant to express ideas, and lacking in independent thinking and reasoning. Given that circumstances have changed since the launch of the 'character-building education' reform, this study provides more accurate information about how high school students in China participate in classroom dialogue through talk. Overall, students generally talked infrequently but their verbal contributions had a rather high level of quality. The classroom dialogue happening in Chinese high schools was mainly led by teachers in an inflexible authoritative manner, and students' verbal contributions were largely made at teachers' requests or initiation. There was little of the exploratory talk or constructive meaning making recommended by Wells (1999) and Mercer (2008), similarly to many of the situations reported in Western countries (see e.g. Burns & Myhill, 2004).

The histograms for all the talk scales were left-censored. This indicates that, in Chinese high schools, students' verbal contributions tend to be unbalanced, with many students making no or only a small number of verbal contributions, while the talk contributed by a few students occupied most of the classroom dialogue. One reason may be that, with a large population, Chinese high schools often accommodate many more students than those in Western countries such as the UK or America. With a limited number of faculty, it is common to see 50 more students sharing one class, and it is impossible to give every student a chance to talk in a 40-minute lesson, otherwise teachers could not possibly keep up with lesson plans and meet curriculum objectives (Burns & Myhill, 2004). Thus, a wish to enable each individual student to have opportunities to talk and interact fully is hard to achieve in Chinese high school lessons.

In terms of frequency of talk, most students were quiet and less talkative, while a small number of students talked frequently. To be specific, in these Chinese high school classes, raising hands to answer questions initiated by teachers was the main form of student participation in classroom dialogue. In contrast, relatively fewer students expressed ideas or asked questions when the teachers had not initiated a dialogue. The suggestion was that the classroom dialogue in Chinese high schools proceeded in an orderly manner, and were led by teachers in a pre-determined ways. Moreover, these Chinese learners tended to answer questions and follow the teachers' instructions and guidance. Quite a few students showed a high intention in response to teachers' questions, which is a positive change compared to earlier findings (e.g. Purdie & Hattie, 1996), and it would be arbitrary to label all Chinese learners as passive when it comes to talking. However, Chinese learners tended to lack questioning and were relatively inactive in self-exploring knowledge. This pattern has been reported in some other studies, for example Kennedy (2002), in which Chinese learners were found to show less willingness to raise questions with teachers or influence their peers through discussion and argument. This is probably because the Chinese are deeply influenced by Confucian ideals, exhibiting a high level of compliance and obedience, and tending to execute orders (Olaussen, 1999). With reference to high school settings, students are not used to questioning authority; namely, their teachers.

Regarding the quality of talk, several features of participation in classroom dialogue in Chinese high schools emerged. The first was that students' contributions displayed a high level of accuracy. One possible explanation is that Chinese learners may have a solid mastery of basic knowledge. This may become an advantage for Chinese students in school learning, especially with reference to subjects such as mathematics and science, which usually have a strict requirement for memorizing formulae and definitions. Notably, it is usually an assessment or replication of knowledge delivered by teachers or in textbooks when answers can be assessed to be right or wrong (Vande Veen & Van Oers, 2017). This in a way reveals that classroom dialogue is largely used by Chinese teachers to review knowledge and check students' mastery of course content. Accuracy was essential when Chinese students answered questions or made comments. The emphasis on accuracy may be caused by the college entrance examination, namely Gaokao, an examination that determines students' university lives and future careers. To maximize fairness, man-made factors need to be reduced and thus most questions in the college entrance examination papers can be answered in standard ways so that students' scores will be less affected by different marking methods. Students are trained to answer questions accurately or in a correct form in their everyday classroom teaching. Given this background, it is understandable that many of the students' verbal contributions displayed a high level of accuracy.

The second feature in relation to the quality of talk was that very little dialogue was concerned with students' personal experiences or invited their subjective opinions. In contrast, an abundant

amount of dialogue was contributed with reference to textbooks, rule-governed answers or previously taught knowledge. This suggested that dialogue in these Chinese high schools had the effect of mainly assessing whether students had mastered course content, while students' individual thoughts were less favoured and developed. There were few opportunities to use talk to actively work on students' own thinking and learning experiences. Students were expected to use predetermined principles to support their statements, which in a way verified the superior status of learning through memorization in Chinese education (Kember & Watkins, 2010). The emphasis on objectives and facts and the lack of personal thoughts seems also to be a worry for classroom dialogue in Western countries. As cited in Burns and Myhill (2004, p.47), "in a heavily accountable teaching culture, highly instructional, objectives-based pedagogy seems to be required, and well-paced, teacher-directed learning are considered valuable, safe approaches".

Demonstration of reasoning was the third feature of Chinese high-school students' verbal contributions to dialogue. This characteristic was also identified in the MPhil study with secondary school students in China (see Song, 2015). As seen from the above two findings, Chinese learners are departing from the image of lacking in critical thinking, as some scholars have claimed (e.g. Gan, 2009; Kember & Watkins, 2010). In this PhD work a more detailed account of reasoning has been achieved, and it has been classified it into four sub-categories: 'analysis', 'generalization', 'speculation' and 'up-take'. This increased explicit understanding of how students reason through classroom dialogue. The average score for 'analysis' was notably high compared to the other three sub-categories, suggesting that many students were getting into the habit of analysing and solving problems reflectively. Through dialogue students were likely to break down complicated concepts, evaluate different ideas critically and give explanations for their answers. Classroom talk has been consciously used to think and analyse problems. For example, in response to a mathematics question, students would explain how they analysed and worked towards a conclusion. This illustration of analysis may be attributed to the implementation of the 'character-building education' reform, which has advocated teachers using classroom talk to foster students' scientific spirit and analytical ability (Zhou & Zhu, 2007).

In comparison, these high school learners displayed relatively low levels of generalizing knowledge, considering possibilities and building up previous ideas through classroom talk. Only a few students engaged in generalization and inductive reasoning in their talk, while a great many speakers were not capable of or unaware of sorting out course content, connecting information or summarizing knowledge. Complicated and abundant as high school course contents are, it seems necessary for students not only to know each part of knowledge separately but also to have a comprehensive understanding. In the high school dialogue there was a lack of inductive reasoning, suggesting that teachers should initiate more dialogue that requires generalizing and formulating

concepts, and that students need to pay deliberate attention to the connections between different parts of knowledge. The average score for speculation was also quite low, indicating that students were unlikely to explore innovative ideas or possibilities through dialogue. In Chinese high schools, with compact teaching arrangements and plans, there is hardly any time for students to go beyond existing information and explore future possibilities. Also, speculation may not be permitted or favoured by teachers as it may risk challenging the teachers' authority when expanded dialogue concerns something that the teacher is unaware of. Finally, the classroom dialogue occurring in these Chinese high schools lacked connections and up-takes. Students tended to talk about their thoughts, while very few of them incorporated, extended or built on previous ideas. A suggestion is that the kind of dialogue which fosters up-take should be encouraged as this prompts arguments and discussion which may deepen and expand students' understanding of problems. The above findings contribute to the knowledge of how Chinese high school students currently participate in whole-class talking. Changes have taken place not only in the amount of talk contributed by students, but primarily in the quality of talk. Chinese students are breaking away from the stereotype of silent or passive learners indicated in many previous studies (e.g. Kennedy, 2002), and my study has provided a detailed account of students' participatory behaviours. This knowledge may help teachers and students strategically increase the quality of talk and create more productive classroom dialogue.

A variety of individual characteristics has been related to talk in classroom dialogue, of which gender, ethnicity and academic achievement have been the most frequently studied (see Howe & Abedin, 2013). Yet most studies have focused on primary and secondary school pupils, while very few materials have looked at the circumstances of students aged 17-19 years; namely, those in high schools. This study fills this gap and examines how relevant individual characteristics correlate with talk contributed by high school Chinese learners. Ethnicity was irrelevant in this study as all participants were Chinese. The relationship between talk and academic achievement is discussed in later sections, as this relationship is considered in response to one of the research questions. What is left here is an examination of the relationship between gender and talk in classroom dialogue. In these Chinese high schools, female and male students made similar numbers of verbal contributions to classroom dialogue. As suggested by Duffy et al. (2002), when studies have focused on younger students (i.e. primary or secondary school students), they have been more likely to find that boys and girls differ in the frequency of talk, while studies focusing on older students (i.e. high school or college students) tend to find little or no gender difference. This study supports this suggestion as there was no significant gender difference in relation to the frequency of talk when high school Chinese students served as research participants. We can probably infer from the above findings that when students become older their gender identities become less relevant to the number of verbal contributions they make to

classroom dialogue. Yet the quality of talk contributed by these high school boys and girls varied. Boys' contributions were more likely to be rated as correct than those contributed by girls. Boys tended to show a greater range of analytical processes, consider more possibilities beyond current knowledge, and take up previous talk to a greater extent. Boys' talk showed a high level of cognition, which may increase and deepen their understanding and thinking. This may be why it is usually male students who show notable potential and performance in Chinese high schools.

There was rather a big gap in relation to the frequency and quality of talk contributed by students from different schools. Students from the lower-ranked school were less likely to answer questions initiated by teachers or to raise questions than those from the higher-ranked school. A major distinction between schools lay in the quality of students' verbal contributions. In those schools ranked as low level, students' talk usually displayed low levels of accuracy, suggesting that they were far from reaching course objectives. Their talk also showed a lower level of cognition than that in schools ranked as high level, especially in relation to analysing problems. This is probably a reason for the distinction between the schools. In higher level schools, students and teachers made better use of classroom dialogue to memorize knowledge, strengthen understanding and analyse problems. In comparison, classroom dialogue in lower level schools was less effectively used, particularly in initiating critical thinking. The results suggest that schools might increase their quality by emphasizing the use of dialogue in classroom teaching and learning, and efforts should probably be made to look at how talk can be altered and adapted to maximize students' learning.

5.2.2 Listening in classroom dialogue

In studying participation in classroom dialogue, the focus of present work has been on talk, with few studies taking account of listening as a form of participation. Recent years have seen a rise in proposals to include silent participants in studies of classroom dialogue, yet more often a theoretical or qualitative approach is adopted while little material measures listening quantitatively. This study has made an attempt to fill this gap through designing a self-report questionnaire in which listening in classroom dialogue is taken into account by looking at the amount of time students report spending listening, listening experiences and perceptions of achievement after listening to classroom dialogue. The questionnaire was tested twice and generally found to be reliable and valid. The first test was during a pilot study with 75 students and the results showed that the questionnaire's construct validity and internal reliability were both high. In the formal fieldwork 289 high school students filled in this questionnaire. Exploratory and confirmatory factor analyses confirmed that, after deleting two items, the questionnaire had satisfactory construct validity and good internal reliability. The two deleted items were designed to help understand whether listening helped with creativity and knowledge application

but these Chinese high school students were less likely to encounter such kinds of learning experiences in their daily school lives. To purify and test the questionnaire, future study may need to use it with students who have greater chances to access the kind of classroom dialogue that initiates creativity and applies existing knowledge to novel situations. My study is an original one in its use of this questionnaire, and the items designed are primarily based on the experiences of Chinese school students. Caution should be used when translating and using it with students in other countries and social contexts. Certain items may need modifying in order to cater for students in a particular context. More empirical evidence is needed before the results of the questionnaire can be fully convincing. Nevertheless, my study has made a novel attempt to assess listening in classroom dialogue quantitatively and this contributes to the understanding of silent participants on the basis of statistical evidence. This is expected to advance the research on classroom dialogue.

The results indicate that, in Chinese high schools, students are likely to be involved in classroom dialogue through listening. Many students spent a considerable amount of time listening to the teacher and their peers talk, and less variance was seen in relation to the amount of listening. This implies that most Chinese high school students have developed a habit of attentive listening and paying close attention to teachers' course delivery and other students' thoughts. This helps them to master course content, take in useful ideas, assimilate new information and develop understanding. Listening to teacher talk is necessary and highly emphasized in Chinese high schools as it ensures students' scores in Gaokao, which has a high requirement for mastery of basic knowledge (Zhou & Zhu, 2007). Thus, it is understandable that most students rated highly in frequency of listening. However, it should be noted that students may risk forgetting their own thoughts and lose reflective thinking abilities if they get used to only listening to others and accepting facts. Despite generally spending a long time listening, students reported that they had various listening experiences and achievements in classroom dialogue. A number of students viewed themselves as having more comfortable learning experiences when listening to others' talk than asking or answering questions themselves. Moreover, some students perceived themselves as memorising knowledge better, thinking more critically and solving problems better when they remained attentively silent compared to talking in classroom dialogue. Remaining silent to listen is a preferred method of participation in classroom dialogue for a certain number of students, and these students were more likely to be silent participants.

Female students were more likely than male counterparts to pay attention to the teacher's course delivery, their classmates' talk and to take notes to help with listening. In comparison, males generally reported themselves to have a shorter attention span during classroom teaching. Two possibilities may underlie these differences. The first is that many boys prefer to be involved in classroom dialogue through talk rather than through listening. They might spend more time raising questions and giving

answers, thus sacrificing part of their listening time. However, the results showed that boys and girls did not differ in the amount of talk contributed to classroom dialogue. Thus, the first possibility is ruled out. The second possibility is that male students are more likely than females to lose interest in course content, be distracted or behave improperly to disturb classroom teaching. Duffy et al. (2001) found that, in US high schools, teachers directed more attention and interactions toward male students than toward female students. This was mainly in an attempt to "keep their interest who might otherwise lose interest and/or disturb the class" (p. 591). The finding of Duffy et al. in a way suggests that boys' short listening times can be best explained by the second possibility. Teachers may need to direct more attention to male students and use different strategies to keep their focus.

As a learning method listening in classroom dialogue was employed variously in the different schools. Students from the school ranked lowest, namely No. 3 Middle School, tended to spend less time listening to teachers' course delivery and their peers' thoughts, and were easily distracted from lessons. Moreover, significantly more students in No. 3 Middle School than in the other two schools perceived themselves as having better learning achievements when they were involved in classroom dialogue through listening compared to talking. It is very likely that in the lessons of No. 3 Middle School many students remained silent and classroom dialogue was less interactive. If this situation was allowed to develop, it might risk creating a non-interactive atmosphere in classroom teaching where the teacher delivers a course while very few students talk. It is likely that some students who might be willing to contribute through talk may choose to keep silent in a non-interactive class. This would discourage students' enthusiasm for learning, prevent them from getting access to different thoughts, and impede their independent thinking, contributing to the low ranking of the school. As suggested by O' Connor et al. (2017), a culture of active talk in classroom dialogue needs to be ensured over the long run.

5.3. Learning outcomes

Learning outcomes are typically measured by academic achievement, yet achievement measures are often claimed to be weak in terms of assessing critical thinking, creativity and knowledge application. Increasing these aspects is essential for gaining desirable learning outcomes, and is seen by many scholars as a goal for classroom dialogue. Thus the study considers both academic achievement and cognitive abilities to account for learning outcomes.

In the Chinese high schools that were studied, male students were more likely to score highly in mathematics and physics subjects than their female counterparts. In the English examination it was female students who usually showed better academic achievements. It is suggested that this is caused by gender differences in cognitive ability (Hedges & Nowell, 1995), and this implication is supported

by this study's findings. Mathematics and physics in high school have a very high requirement for reasoning, especially in the analysis of quantities and figures (Fennema, Sowder, & Carpenter, 1999). This study found that boys achieved a significantly higher level of quantitative analytical ability than girls. Thus, it was understandable that boys and girls had varied achievements in different subjects. Additionally, students in high and middle ranking schools generally showed similar performances in academic achievement and cognitive ability but significantly surpassed those in the lower ranked school. This suggests that, in China, school matters to high school students' cognitive development and learning, and selecting a school with a fair rank seems to be essential.

The significant correlations between academic achievement and aspects of cognitive abilities indicate that students' academic scores can partly reflect their level of cognition or vice versa. Students' mathematical achievement is closely related to their quantitative analytical ability, figure analytical ability and figure practical ability. Physics achievement were correlated with most of the cognitive abilities involved in analysis, creativity and application. English achievement only relates to verbal analytical ability. Referring to the average scores of the three subjects, students generally performed best in English, followed by mathematics and then physics. The relationship between academic achievement and cognitive ability can probably be used as an explanation. A much greater variety of cognitive abilities is needed to achieve a good score in a physics test than in an English test; thus it is understandable why the mean for physics is much lower than that for English. Another interesting indication is that the test paper designed by the Chinese education agency is not merely an examination of memorization of content in textbooks but also takes a comprehensive account of students' cognitive ability. In general, the ability to analyse problems is emphasized in the exam tests of all three subjects, while the ability to apply knowledge and propose creative ideas is considered to a lesser degree.

5.4 The relationship between participation in classroom dialogue and learning outcomes

Classroom dialogue is viewed as an essential tool for teaching and learning, and heavily related to academic performance. The discussion about whether participation in classroom dialogue facilitates learning, and the effects of different forms of participation, still continues. This study focused on high school students in mainland China, a group that has rarely been studied before, and found that these students' learning outcomes were significantly correlated with, and at the same time could be predicted by, their participatory performance in classroom dialogue.

To be specific, two forms of participation have been taken into account in relation to learning outcomes; namely, talk and attentive listening. According to the review conducted by Howe and Abedin (2013), a number of scholars hold a belief that contributing more and higher-quality talk are

essential for achieving an ideal learning outcome, and there is empirical evidence of the benefits of talking obtained from the primary and secondary school students who were chosen as the research focus. The similar benefits also applies for high school students, as they are found to be more likely to achieve high academic scores in mathematics, physics and English, and to show quantitative analytical ability, when their talking shows a higher level of accuracy and cognition. Additionally, talking more frequently is also likely to facilitate English achievement. This is probably because talk in classrooms impels students to pay careful attention to course content and encourages them to think actively, as contributing to talk requires "organizing concepts, formulating arguments and counter arguments, and responding thoughtfully and critically to diverse points of view" (Davis, 1993, p. 63). Through this process they may solidify their memorization, deepen their understanding of course contents and their increase problem-solving ability, which then leads to better academic performance. Moreover, classroom talk in these Chinese high schools was characterized by a high level of analysis. Students would talk about their reasoning processes and give an explanation of how they solved problems. When used in mathematics or physics lessons it is understandable that talking in classroom dialogue promotes quantitative analytical ability. Noticeably, the quality of talk was more important for mathematics and physics learning compared to its frequency. This implies that, compared with contributing more talk, teachers and students should probably pay more attention to the accuracy and cognitive level of talk, and fully exploit a question or a topic to develop students' thinking. This is especially true in a whole-class context where limited opportunities arise for each student to talk.

Another explanation is that positive predictions of learning outcomes from verbal contributions may be affected by students' previous academic performance. Some students who like to be involved in dialogue through talk may have originally been high academic achievers, and they may continue to keep their superior status in learning. It may be arbitrary and inaccurate to state that all high academic achievers are likely to talk a great deal and make high levels of contributions; nevertheless, this group as a whole certainly contributed a higher quality of talk than those who achieved low scores. This is especially true in Chinese high school contexts, where students usually need to refer to content in textbooks or that delivered by teachers to support their ideas when answering teachers' questions. This means that students should have a good basic knowledge and a sound level of cognition to analyse and solve problems if they want to contribute to talk, particularly with respect to the subjects mathematics and physics. High attaining students are certainly more capable of answering or asking questions than those attaining low scores. Moreover, given that high school learning in China emphasizes accuracy, low academic achievers may worry about being criticized by their teachers if they give a wrong answer. Additionally, a short time was often left for students to think before an answer was needed, and students who had a solid mastery of knowledge, namely high academic achievers, should be more able

to come up with an appropriate answer within a limited time. Given the above three factors, students who had previously had higher learning outcomes were more capable and prepared to talk in classroom dialogue.

Two possibilities arise from making a verbal contribution. One is that a student may be suited to learning through talk, and therefore talking more (e.g. answering more questions, being more involved in discussion and raising questions) and contributing a high quality of talk after careful thought further promotes his/her thinking, understanding and learning. The other possibility is that a student may prefer not to talk but sometimes takes on the responsibility for being a so-called 'good student', for example answering questions when necessary so that the teacher will not feel embarrassed. Given that this kind of situation is not abundant, answering a question or two in one lesson may not exert much influence on his/her learning, and they continue to achieve high learning outcomes. Due to the characteristics of the participants, as described in Section 3.3, previous academic scores could not be obtained before observing class participation. Future studies may need to take account of the learning outcomes both before and after students' class participation. Nevertheless, my study adds empirical evidence to the discussion concerning whether classroom talk would facilitate learning. In the past, many scholars and teachers have held a belief in the benefits of talking, and they have called for the involvement of most or all students in talking actively in class (e.g. Dallimore et al., 2010; Mercer & Littleton, 2007). However, relatively few studies have been capable of providing positive empirical evidence (Howe & Abedin, 2013; Mercer, 2008). Moreover, many scholars have taken an interventionist approach and the dialogic teaching methods have been designed specially, which are extremely rare in normal classes (see e.g. Mercer & Littleton, 2007). There is a great need for empirical evidence to show the positive effect of talking in normal classroom settings. My study has filled in this gap by providing statistical evidence that talking, especially high-quality talk would facilitate achievement in mathematics, physics and English. With this knowledge, scholars and teachers would probably be more confident about endorsing the value of talk.

Apart from talk, students can also be silent participants in classroom dialogue, and I found that the more time a student spends listening, the better he/she would do in mathematics and physics subjects. The finding implies that ensuring a certain amount of listening to teachers' course delivery and other peers' thoughts tends to help with high school students' learning in mathematics and science. This is probably because when remaining in attentive silence, students can settle down to learn from others' ideas, assimilate new information and have time to reflect on information deeply. All of these are necessary in mathematics and science learning as these subjects have high requirements for critical thinking and mastery of pre-existing knowledge and methods such as formulas and disciplines. This finding is similar to a very recent piece pf research done by O' Connor et al. (2017), who identified no

significant differences in learning outcome between vocal and silent participants in classroom dialogue. However, it is notable that spending much time in listening may not help with English academic achievement, possibly due to its subject features. People are usually required to speak and communicate more to gain practice in language learning.

So what do these results mean for research and practice? Previously, many scholars only considered talk when studying participation in classroom dialogue, and when a positive relationship was found with learning they gave the advice that all students should be encouraged to talk actively in classroom dialogue (e.g. Dallimore et al., 2006). Similarly, in practice, it has been found that many teachers worry about students who remain silent and try to include most or all of their students in each discussion (see O' Connor et al., 2017). This makes productive and deep dialogue less likely to happen (O' Connor el al., 2017). Now it is known from this study's findings that ensuring a certain amount of time in listening is likely to provide similar learning benefits in mathematics and physics from dialogic interaction as those produced by participation through talk. An implication for practice is that, in mathematics and science classes, teachers probably could leverage more freedom in an attempt to create productive dialogue; for example, carrying out in-depth discussion around one topic rather than simply following the IRF steps in order to include most students in talking. In the short run students can learn by choosing to participate either through talking or listening, and "one can be chosen over another without harming a student's chances of understanding or learning" (O' Connor, et al., 2017, p. 12). Over the long haul a culture of interactive dialogue should be in place. The role of teachers probably needs to move away from an authoritative position. A more equal and democratic relationship between teachers and students needs to be constructed. Teachers should try to create an atmosphere that facilitates interaction, values diverse ideas and encourages discussions, so that those prone to talking will have the courage to express their opinions in front of the class.

5.5 The relationship between thinking style and participation in classroom dialogue

In these Chinese high schools, students' participation in classroom dialogue was closely related to, and at the same time could be predicted by, their thinking styles. Whether students engage in dialogue through talk or choose to remain attentively silent in order to listen is predicted by their thinking styles. This finding supports and extends that achieved in the earlier MPhil. Also, in the past, many individual characteristics have been related to classroom dialogue (see Howe & Abedin, 2013), but relatively few studies have been concerned with thinking styles. The findings obtained in both my MPhil and PhD studies confirm that thinking style is one of the individual differences that affects whether and how

students participate in classroom dialogue. Thinking style, together with other factors, contributes to the understanding of why some students tend to talk while others remain silent.

Students who showed a preference for participating in classroom dialogue through talk were more likely to be those characterized with a Liberal-Group style. Students characterized by a Liberal-Group style tended to be talkative and were likely to make a high level of verbal contributions. They generally answered more questions initiated by teachers and raised more questions. Their contributions tended to have a high level of accuracy, include content from textbooks to support ideas, and reflect information more critically. Moreover, many of these students expressed an unwillingness to learn by merely listening to others talk, as remaining silent in class brought them less desirable learning experiences. This interpretation may be justified as follows. The Liberal Group is positively dominated by liberal, legislative, judicial and hierarchical styles. The first main component is a liberal style, which makes people express a favour of new ideas and thoughts. When students have unique answers to teachers' questions or new ideas to solve a problem, they are more likely to have a desire to share with others rather than keep them secret, which may make them talkative. Additionally, the liberal style arms students with a preference for exploring the unknown and pioneering new methods. Thus, the talk contributed by liberal students may be more than a replication of course content but shows a process of speculating and extending knowledge. Another main component of the Liberal Group is the legislative style. Students relatively legislative are not willing to learn by passive rote; instead, they are likely to come up with their own ideas and develop their own individual ways of perceiving learning content. Thus they are very likely to contribute to talk in front of their class, instead of remaining silent and passively accepting ideas. At the same time, when talking in class, they are very likely to justify and explain how they arrived at a solution, which endows their talk with high value. Acting as an essential component of the Liberal Group, the judicial style may impel students to get into the habit of evaluating, comparing and analysing learning content. This helps students to come up with correct and thoughtful answers (Zhang, 2004), which seems to make a major contribution to high-quality answers and comments. The fourth main component of the Liberal Group is the hierarchical style, which allows people to cope with several tasks in an orderly manner. This enables students to take notes, memorize and think at the same time as coming up with an answer and then organizing language to talk in class. With the characteristics of its main components explained, it is understandable that a combination of the liberal, legislative, judicial and hierarchical styles predicts more frequent and high-level talk, while leading to weak willingness to learn by listening.

In contrast, students characterized with an Internal-Group style generally talked little and their talk tended to show a low level of correctness and was less likely to show reasoning process. They were less likely to respond to teachers' initiations by raising their hands, although an answer might be

formulated in their minds, and they rarely asked questions in class. Nevertheless, this does not mean that students dominated by the Internal-Group style were less attentive to course content and classroom dialogue, as they spent a considerable amount of time listening, and rated themselves as having desirable listening experiences and high achievements through listening. The Internal Group is positively associated with an internal style, but negatively associated with an external style. Students characterized with an internal style prefer to think and work alone rather than communicate with others, and thus it is not surprising to see lower talkativeness on their part in class. It usually takes time for this kind of student to internalize and transform information received from the outside into their own ways of understanding. Teachers usually leave a very short time for students to think before inviting them to give an answer. When this kind of students contribute a talk, it seems likely that they have not understood or thought about the problem properly, which may make their contributions less accurate and thoughtful. In this situation, such students choose to remain attentively silent to listen to others' talk, which may allow them space to understand problems deeply and think critically. An external style is characterized by enjoying communication and working collaboratively with others. Students who had a low tendency to this style may be less likely to express their ideas in public, discuss or argue with their peers. The above seems to be a reasonable justification for why the students characterized with an Internal-Group style were more likely to be involved in classroom dialogue through listening than talking in front of the class.

Similarly, students dominated by the Conservative-Group style were also likely to be silent participants for the reason that they tended to perceive remaining attentively silent in order to listen as more comfortable and likely to result in a high learning achievement. Conservative, executive, monarchic and oligarchic styles have high loadings on the Conservative Group. The conservative style is typically described as resistant to change, and taking longer to get used to new methods and learn new knowledge. Given the short time allocated for each question, students characterized by a conservative style may not be capable of responding in a timely manner or they may intentionally make use of silence to digest learning content. Similarly, students who are relatively executive tend to receive information passively and follow instructions, and thus it is not surprising to see them show a preference for remaining as attentive listeners. Students dominated by the monarchic style focus on one task at a time, and remaining attentively silent in class which may allow them to concentrate on taking notes and teachers' course delivery. Unlike the hierarchical style described above, people characterized by an oligarchic style easily become disorganized when coping with multiple tasks. They may feel overwhelmed by coping with teachers' questions at the same time as taking notes, and it is probably safer and more productive for this kind of student to participate in classroom dialogue by listening. Given this interpretation of its main components, it is understandable that listening

experience and perception of achievement through listening can be positively predicted by the Conservative-Group style. With their preference for listening, however, Conservative-Group students may get used to only receiving information, which may run the risk of losing a chance to express their thoughts in front of the class, to be corrected by teachers, and to have their mastery of course content checked by teachers.

High school students in mainland China generally spend a considerable amount of time listening, except for those characterized with a Global-Group style. The Global Group features a high positive loading of global style and a high negative loading of local style. The dominance of the global style together with the lack of the local style arguably causes people to emphasize an illusory future while overlooking practical work. Students characterized with this type of style may miss necessary lesson content if they find listening in classroom dialogue less necessary. This is especially true for high school Chinese learners as they face Gaokao and of the need to master basic knowledge.

5.6 The relationship between thinking style and learning outcome

In these Chinese high schools, there was little or no relationship between students' thinking styles and their learning outcomes, including academic achievement and cognitive ability. The finding concerning cognitive ability is in alignment with both the theoretical construct proposed by Sternberg and previous empirical evidence (e.g. Sternberg & Grigorenko, 1995). This confirms that thinking style is something different from ability, with ability being used to describe how well one can do something, while style is a matter of the approach used to cope with tasks (Sternberg, 1997).

Regarding the finding about thinking style and academic performance, this is quite unusual as most studies conducted during the years 2000 to 2007 have indicated that thinking style affects how one performs in academic tests, and that some thinking styles are rewarded over other styles in particular education systems. Yet results regarding which specific thinking style is favoured vary to a large extent across different regions and education systems. Styles that are rewarded more in one region or education system tend to be less favoured in another. For instance, students in regions like Hong Kong and the Philippines were found to be more likely to achieve better scores when they were characterized with styles that adhered to pre-existing rules (i.e. executive style), while those who were more norm-challenging (i.e. liberal style) tended to be penalized in examinations. The judicial style was found to be common among American students achieving high academic scores. Many students characterized by a style enabling students to pay attention to details, namely the local style, were identified as good academic achievers in mainland China. Educational systems matter in the relationship between thinking style and academic performance (Sternberg, 1994). This in a way reflects the idea that the assessment tasks and methods in academic tests seem to be overly simplistic,

and lack a comprehensive examination of students' learning. Important biases exist in education which favour particular thinking styles (Cano-Garc á & Hughes, 2010). For instance, tests favouring the executive style or local style may be overloaded with closed questions such as multiple-choice questions, which emphasize memorization of pre-existing knowledge in textbooks. Tests favouring the judicial style may be overwhelmed with open questions which invite students to show their reasoning processes. Regarding the above situations, Sternberg (1994) has stressed that academic tests should be designed in a way that takes into account the diversity of individual styles; for instance, including varied assessment tasks so that learning outcomes can be assessed in a fashion that is congenial to most students.

Since the launch of "character-building' reform in mainland China, strong demands have been made on students' critical thinking, creativity and knowledge application, apart from memorization of basic knowledge. In implementation a diversity of assessment methods and tasks have been included in tests and examinations, including closed and open questions (Zhou & Zhu, 2007). For instance, in English test papers there are multiple choice questions which focus on assessment of basic knowledge, cloze tests check grammar and inductive thinking, reading comprehension highlights students' in reasoning and summarization abilities, and writing invites students to think independently and creatively. Such assessment seems to be able to take into account a diversity of thinking styles. Thus it makes sense that in the results of this study, students characterized with different thinking styles were equally likely to learn well in these Chinese high schools. Moreover, the findings are compatible with the theoretical assumption proposed by Sternberg (1997) that thinking style is a matter of fitness and suitability, rather than something that can be evaluated with a hierarchy. "Styles are not better or worse, but merely different" (Sternberg, 1995, p. 268). If a thinking style is habitually favoured in one education system and leads to better achievement, as in the results achieved by some other scholars, people may value it over other styles, which may be contrary to Sternberg's intention.

5.7 The relationship between thinking style, participation in classroom dialogue and learning outcomes

Based on the above it appears that both talk and listening in classroom dialogue can facilitate learning. Yet at the individual level different forms of participation in classroom dialogue favour students variously. Which kinds of students are more suited to learning by talking? Which kinds of students are more likely to learn well through attentive listening? Few studies have previously connected individual characteristics, classroom participation and learning outcomes, together. Induction from the literature implies that thinking style might be a factor that moderates the relationship between participation in classroom dialogue and learning outcomes. This hypothesis has been verified by the results attained

from this study's moderation regression analysis. Students' thinking styles affect whether and how they benefit from participation in classroom dialogue. Although the effects were generally weak, the findings provide a new possibility for studying the relationship between classroom dialogue and learning.

For students characterized with the Liberal-Group style, contributing high-quality talk in classroom dialogue appears to add to their mathematics achievement, while spending a long time listening tends to bring them adverse effects on mathematics and physics learning. In Section 4.5, it was found that students characterized with a Liberal-Group style preferred to participate in classroom dialogue through talk, and they were not likely to be silent participants. When these students were allowed to learn using their preferred method they had a greater chance of learning well in mathematics. This was probably because contributing high-quality talk brought their thinking superiority into full play. By contrast, acting as silent participants is not to their liking; however, teachers may provide limited chances for students to talk, and thus they have to keep silent even though some may want to express ideas, for example those featuring in the Liberal Group. Intentions to explore creative ideas are then suppressed, unique and independent thoughts cannot be demonstrated and argued, and the wish to think critically through discussion cannot be achieved, all of which are especially necessary in mathematics and science. Students may thereby lose chances to learn and thus it is understandable that they will perform poorly in mathematics and physics subjects if they spend a long time listening.

Students characterized by an Internal-Group style seemed less likely to achieve high mathematics scores when they made too much frequent contributions that displayed high levels of accuracy and cognition complexity. Referring to the findings in Section 4.5, students dominated by the Internal-Group style prefer to be attentive listeners in class rather than talking actively. This implies that this kind of student may be suited to learning through listening. However, if for some reason they contribute a significant amount of high-quality talk, this may have an adverse effect on their mathematics performance. Students dominated by the Internal-Group style prefer to think and learn individually, and a relatively longer time is needed for them to reflect on information and transfer the exterior knowledge into their own understanding. With a short time given for preparation in class they may have to sacrifice the time for taking notes and gaining deep understanding, and a chance to learn from others' talk, if they strive to contribute proper answers or show their thoughts in front of the class. This may be a reasonable justification for the negative effect of the Internal-Group style on the relationship between quality of talk and mathematics achievement.

For students who had a high tendency towards the Global-Group style, listening attentively in classroom dialogue would add to their mathematics scores when they perceived themselves as having attained the desired level of achievement. A possible explanation may be that students characterized

with this kind of style were found to dislike listening to teachers' course delivery and other students' talking, and could easily be distracted from concentrating on the course content. I referred in Section 5.6 to the fact that this might prevent them from achieving good academic scores, due to the special circumstances of Gaokao in China. This is especially true with respect to mathematics subjects, because of the complex formulae and algorithms. If, however, students characterized with the Global-Group style could listen carefully to course content, and try to memorize and think during the process of listening, it is likely that they found themselves as having better learning achievement, which would then increase their mathematics scores.

The implication of the above findings is that student preference as regards learning methods should be expected. At the individual level both vocal and silent participants are likely to achieve good learning outcomes. The traditional approach of judging silent students as less capable is inappropriate, and talkative students should not be favoured over silent ones. Talking and listening are different forms of participating in classroom dialogue, and they may bring diverse learning effects for each individual participant. What matters is helping more students to understand their individual characteristics, for instance, their thinking style, and to develop different strategies, either talking or listening, to maximize their use of classroom dialogue in order to learn.

5.8 The results achieved from qualitative analysis

The purpose of conducting qualitative analysis was to provide a supplementary understanding of the results obtained from the quantitative analyses; namely, how students perceive the relationship between thinking style, participation in classroom dialogue and learning outcomes. In particular, the intention was to demonstrate the mechanisms and processes involved in students' thinking styles affecting how they benefit from classroom participation. This purpose has been generally fulfilled.

The interviewees selected were involved in classroom dialogue in diverse ways, with some talking frequently while others were rather quiet. Various methods of participation were adopted, nevertheless students' intentions were the same in that most or all of them expressed a willingness to learn well. They viewed a particular method of participation, either talk or remaining attentively silent, as more beneficial to their learning, for example by increasing memorization, deepening understanding or promoting critical thinking. They also expressed a strong sense of self-control about their learning process, and were free to learn using their preferred methods. This generally endowed them with a satisfactory and comfortable learning experience, which they felt was helpful for their learning achievement.

All interviewees believed that individual characteristics played an essential role in affecting their class participation and the learning outcomes they achieved through particular methods of classroom

involvement. It was deduced from their statements that each individual's thinking styles did affect his/her choice of either talk or silence in classroom dialogue, and how they benefitted from this particular selection. However, the students themselves seemed to be less aware of this effect. A possible reason for this is that thinking style was a rather novel concept to these Chinese high school students and many of the interviewees indicated that they had never heard of it before. They generally had a rather vague self-awareness of their thinking styles: the specific characteristics they featured, and strengths and weaknesses of their thinking methods.

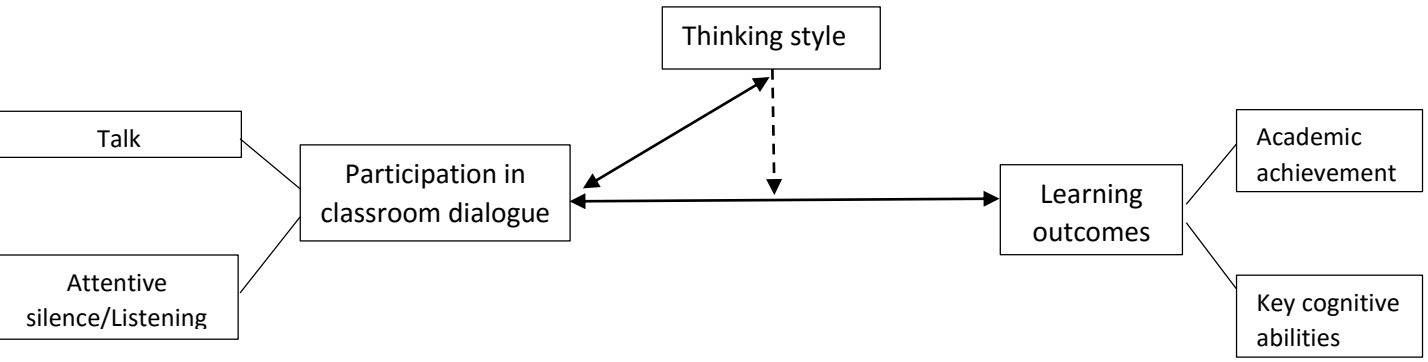
Given that thinking styles have been proved to be influential in class performance, it seems necessary to introduce teachers and high school students to the definition of thinking styles, and to help them learn about their typical ways of thinking. Schools and teachers could arrange a lesson to introduce students to the definition and function of thinking styles. With a better understanding of how they tend to think, each individual student could strategically approach suitable methods, namely listening or talking, to be involved in classroom dialogue in a lesson. This might give them a greater possibility of being high achievers and maximizing their potential. Additionally, awareness of weaknesses in thinking styles might lead students to intentionally make improvements in their thinking and learning by making use of classroom dialogue. For example, a student showing weak judicial thinking could try to make more verbal contributions as this process would force them to think critically and give explanations for their answers. Classroom dialogue could therefore be made use of more effectively, promoting academic achievement and cognitive ability.

The implication for research is that individual characteristics and academic performance are both necessary when studying participation in classroom dialogue. They both play important roles in determining whether or not students participate and how they are involved through talking or listening. Their participation behaviours in turn affect their actual learning achievement, and partially shape their individual characteristics, such as thinking styles. Individual characteristics, participation in classroom dialogue and learning outcomes form a stable triangular relationship. There may be a bias if scholars relate classroom dialogue only to individual characteristics or learning outcomes, while not view these three parts as a whole. In the future, more students should explore how different individual characteristics besides thinking style affect the learning outcomes students achieve from participation in classroom dialogue.

5.9 Model adjustment and discussion

Before collecting data, I drafted a model attempting to manipulate the relationship between thinking style, participation in classroom dialogue and learning outcomes. Results achieved in my data allowed me to return to the model and adjust it in the light of my specific findings. Regarding the first pair of

relationships, participation in classroom dialogue, including talking and listening, was found to affect students' learning achievement. Apart from this, quantitative findings suggested that prior achievement may influence students' participatory behaviours in turn. Analysis of interview transcripts provided me with the knowledge that motivation to achieve good learning outcomes caused students to become involved in dialogue in a particular way. Thus the double-arrow line connecting classroom participation to learning outcomes is kept. Secondly, thinking style proved to be one of the individual characteristics that affected whether and how students involved in classroom dialogue, as hypothesized. In the revised model following, I also kept the double-arrow line connecting classroom dialogue to thinking style, indicating that the relationship might also work the other way around. My findings suggested that students might transform from being talkative to remaining silent and tending to work alone in a less interactive classroom environment, where most class time was used for course delivery with teachers being unlikely to invite dialogue. Involvement in classroom dialogue through a particular habitual way and constantly over a long time may change or shape their thinking styles. This in a way supports the proposal that styles are malleable, and are adaptable to a certain environment. Thirdly, there was no significant relationship found between thinking style and learning outcomes in my study, and thus the line connecting these two variables is removed. Finally, the hypothesized moderation effect of thinking style on the main relationship was supported.



Chapter 6 Conclusion, limitations and contributions

6.1 Conclusion

In conclusion, this report investigates the relationship between thinking style, participation in classroom dialogue and learning outcomes, with a special focus on Chinese high school students, a group with relatively little prior research. Each pair of relationships among the three variables has been examined, together with an exploration of the overall connections between the three variables. The whole report started by discussing the first pair of relationships: whether participation in classroom dialogue facilitates learning outcomes. The study confirmed that talking in classroom dialogue promotes high school students' learning in mainland China. The frequency of talk was found to be a contributor to English learning, and the quality of talk tended to facilitate mathematics, physics and English learning, as well as quantitative analytical ability. Apart from talk, ensuring a certain amount of time spent in listening has also been found to facilitate mathematics and physics achievements, yet may be less efficient for promoting English learning and cognitive ability. In order to understand how students can make better use of classroom dialogue at the individual level, the concept of thinking style was brought in and related to classroom participation and learning outcomes, respectively at first. The second pair of relationships concerned thinking style and participation in classroom dialogue, which were studied in response to the second research question. Thinking style has been proved to be an individual factor that significantly influences students' participation in classroom dialogue. This in one respect confirms that the results achieved in the earlier MPhil study can be replicated with high school students. At the same time, the findings extended on those attained in the MPhil, as both vocal and silent participants were considered, and both of their performances correlated with thinking styles. Students characterized with a Liberal-Group style tended to make more and higher quality verbal contributions in classroom dialogue. Yet remaining silent was perceived to bring them less satisfactory learning experiences and achievement. Students characterized with the Internal-Group and Conservative-Group styles preferred to be involved in classroom dialogue through listening. In comparison, students dominated by the Global-Group style were not likely to spend a long time in listening. In response to the third research question, the relationship between thinking style and learning outcome was examined, and few or no significant results were found. This indicated that, in these Chinese high schools, students characterized with diverse thinking styles tended to have similar learning achievements. After understanding how each pair of the variables correlated, an exploratory analysis of the relationships among the three was carried out, and thinking style was identified as affecting how students benefitted from participation in classroom dialogue. For those typically thinking in a Liberal-Group style, producing high-quality talk added to their mathematics achievement,

while listening more tended to bring them adverse effects on mathematics and physics learning. Regarding students characterized by an Internal-Group style, making high-quality contributions to classroom talk tended to prevent them from achieving satisfactory mathematics scores. With respect to students dominated by the Global-Group style, a perception of high achievement through listening strengthened their mathematics scores. Additionally, the results from the supplementary qualitative analysis generally confirmed the findings described above.

6.2 Limitations

Due to the constraints of time and the educational context there are two main limitations of the study that are worth modifying in future research. One is that academic achievement and cognitive ability were considered only once at the end of the term, as it was not possible to obtain information on prior achievements or to measure original levels of cognition before classroom participation. This makes it hard to know whether students' previous academic performance has an effect alongside classroom participation in contributing to their final learning outcomes. This limitation was on the one hand caused by the characteristics of the students constituting my research sample, who had just progressed through the division between scientific and liberal approaches. They transferred from their original classes to form new ones, which made it very time-consuming to pick out these students' previous academic achievements one by one or to test their previous cognitive ability. Given this circumstance, only the final examination scores students achieved after classroom participation were available, and cognitive ability could only be measured once, at the end. Another reason for the limitation was that students' classroom participation was observed for one term; namely, three months. The data collected were in general sufficient for understanding the typical performance of these high school students in classroom dialogue. Nevertheless, the time may have been too short to see an obvious change in cognitive ability caused by participation. This is because cognitive ability has more to do with the mechanisms of how to process information, problem-solve and learn, which usually take time to cultivate and promote (Sternberg & Grigorenko, 2014). Even if it were possible to conduct another test on students' cognitive abilities before classroom observation, there would only be a small chance of finding major changes in their responses. A future longitudinal study involving repeated observations of classroom participation over a long time, probably one school year or more, would be helpful. Academic performance and cognitive ability could then be assessed several times, including both before and after the classroom participation. This would allow people to learn better how students' learning outcomes change after participation in classroom dialogue.

Moreover, in the process of the PhD work, it was found that some of the selected methods have limitations. Firstly, a self-report questionnaire was designed to measure how students participate in

classroom dialogue through listening. A possible criticism is that a self-report questionnaire may cause bias when reflecting on real situations. Yet there is no better method for measuring listening with so many students involved, as it is difficult to observe silence externally. In the future, if only one or two participants are involved in the study, some sophisticated methods (e.g. eye-tracking techniques) may be used for assessing whether students actually listen to course content. Fifteen items were proposed to assess listening from three main perspectives: the time an individual spent listening, whether students felt comfortable after listening to classroom dialogue and whether they perceived themselves to have learnt something after they had listened to classroom dialogue. The questionnaire generally achieved good construct validity and internal reliability after deleting two items and the data collected produced satisfactory results. However, when I presented results, headings, 'frequency of listening', 'listening experience', and 'perception of achievement', were used to represent the above three perspectives correspondingly. These headings seem to be inaccurate in terms of featuring the content of the corresponding items. My external examiner suggested the use of 'attending', 'comfort' and 'application' instead, which are quite reasonable and other possible headings are subject to discussion. Also, items in the questionnaire were proposed according to the experiences of Chinese school students and some of them may not be adaptable to students in other countries. In future studies, particular items should be modified when the questionnaire is used with students in different contexts. To revise items and the corresponding headings, there is a need to apply the revised questionnaire to students in practice; valid and reliable results need to be ensured before we can indicate whether the revised headings are appropriate. I suggest it is better to accomplish this task in the future studies.

Secondly, many parameters, including correlation coefficients and beta value, used to represent the relationship between variables seem to be weak, generally within the range between .15 and .35. In theory, a value below .40 implies a correlation is weak (Hartas, 2010b). However, in empirical studies in the field of education, the parameters used to represent connections between variables are normally around .20-.40, given the complexity of real situations and the many elements that may affect a relationship. For example, in Vermunt (2005), correlation coefficients are generally around .25. Again, beta values reported in Zhang (2008) are within the range of .25-.35. To improve on this, using a larger sample size may be a reasonable choice. Significant results may be more likely to flag up and correlations normally tend to be stronger when a large amount of participants is involved (Hartas, 2010b).

Other possibilities for improvement in future include adopting a longitudinal study to investigate the relationship between thinking style, participation in classroom dialogue and learning outcomes. Students' thinking styles could be assessed several times to see whether they could be shaped by whole-class learning environment, and to understand how flexible students can switch between styles

to adapt to a particular teaching instruction. Also, the analysis of interview data produced many interesting findings, and in the future, a wider range of interviewees should be covered, not just the talkative and quiet students, but also who contribute a medium amount. Finally, the relationship between classroom dialogue and learning is affected by many factors, both individual and environmental factors. I considered thinking style, gender, school and school classes in my PhD work, as they are what I am interested and at the same time, relevant to my context. Apart from these, other factors may also play a role in affecting the learning outcomes that students achieve from participating in classroom dialogue, for example, the nature of learning tasks, discipline and the role of teacher. These should be considered in future studies.

6.3 Contributions and applications

Despite the above limitations, this PhD study still makes several major contributions, as follows. Firstly, both talking and attentive silence/listening have been considered as participatory methods in classroom dialogue, and measuring tools have been designed for quantitative analysis. The coding scheme for observation classroom talk was modified from that originally designed for my MPhil work, and the revised version assesses frequency of talk in four respects, namely TISC, TISNC, TNISC and TNISNC, and measures quality of talk in terms of standard level (i.e. incorrect, partially correct and correct) and cognitive level (i.e. prior knowledge, personal information, analysis, generalization, speculation and up-take). Major polishing has been undertaken in the categories measuring high cognitive dialogue, namely analysis, generalization, speculation and up-take, which are more specific and comprehensive. The revised version shows sound inter-rater reliability and external validity. Moreover, it is manageable for systematic observation, and the data collected is especially adaptable for quantitative analysis. The evidence attained from both the MPhil study and this current one suggest that the coding scheme could be employed in other quantitative studies to measure talk in classroom dialogue.

Secondly, the special focus on high school students in the study contributes to work relating to classroom dialogue and thinking styles. Previously, most studies have focused on primary or secondary school students when examining individual characteristics that are likely to affect participation in classroom dialogue, while relatively little material has targeted students aged 17-19; namely, those in high school. This study partially fills this gap, and has found that there is a difference in talking between high school males and females, and that dialogue contributed by male students tends to show high levels of cognition. Additionally, environmental factors also take effect, in that students from different schools and school classes performed differently in class. The results obtained here can compared with those obtained with younger students. Regarding studies concerning thinking style,

university students are more often targeted and, according to papers published between the years 2000 and 2007, thinking styles are generally reported to have an effect on their learning outcomes. Yet the results are different for high school students, as those characterized by different thinking styles have been identified as achieving similar academic results. This finding on one hand contributes to an understanding of the attributes of thinking style; that it is matter of fitness rather than something that can be ranked in a hierarchy. Students characterized with varied thinking styles may approach learning tasks diversely but nevertheless they have chances of learning well. On the other hand, the finding implies the value and success of the 'character-building education' reform trialled in mainland China. With a variety of test forms, more students could possibly tap their thinking potentials and be rewarded in examinations.

Thirdly, my study contributes to the understanding of the nature of styles. I found that after the implementation of Chinese educational reform, these high school students tended not to follow the stereotype of obeying instructions passively, but were more likely to be characterized with legislative style. This transformation indicates that styles are malleable and can be changed over time, which is an adaptation to the environment. Additionally, gender, being a sociocultural factor, is found to be significantly associated with thinking styles, which supports the notion of malleability of styles. Moreover, there is no significant relationship found in my study between thinking style and learning outcomes, including cognitive ability and academic achievement. Students characterized with different thinking styles are equally likely to learn well. This empirical evidence supports my position that style is value-free and should not be viewed as better or worse, at least in the school context.

Most importantly, this study has made a useful attempt to show how to take advantage of classroom dialogue to learn in a whole-class context. Being a widely used method for teaching and learning, classroom dialogue has drawn much attention in both academia and practice. Helping more students to make efficient use of dialogue to learn has become a concern, or even life-long career, for many educators, and this is also the main aim of this PhD work. Previously, vocal students have been focused on while those remaining silent have been largely overlooked and the function of listening given less attention. It is known from this study that talking and listening are two essential ways of participating in classroom dialogue and, on the whole, they both are likely to promote learning. Talking in classroom dialogue was helpful for the studied high school students' academic achievements and the development of their cognitive ability. This indicates that talking in classroom dialogue is as important for high school students' learning as it is for younger ones. Despite the high academic pressure and compact lesson plans in Chinese high schools, the time and opportunities left for student talking should not be compressed, and those who are willing to talk should be allowed to express their ideas. At the same time silent participants should not be undermined, as ensuring a certain amount of

time for listening has been found to facilitate mathematics and science learning. Talkative and silent students are equally likely to achieve good learning outcomes. This suggests that it may be inappropriate to label or arbitrarily judge silent students as not being capable or active in learning.

The above finding means a great deal to practice in relation to conducting classroom dialogue. With a belief in the importance of talk, many teachers try to involve as many as students in classroom talk as possible, and those remaining silent are called upon to speak. In a forty-minute lesson it is very likely that classroom dialogue has to follow the simple IRF pattern if many students are going to talk, while a deep and constructive discussion around one topic is less likely to happen. An acknowledgement of the benefits of listening could ease concerns about silent students, and there would be more freedom in attempts to creative productive dialogue. Instead of trying to involve as many students as possible in talking in each lesson, teachers and students should probably pay more attention to the quality of talk and how to make use of dialogue to promote thinking. However, over a span of weeks or months, an atmosphere of rich interaction should be in place. Teachers should try to create a culture that values diverse ideas and independent thinking, so that students willing to talk will dare to express their ideas freely.

After understanding the general situation, the findings in this PhD work also instruct us on how each individual student should make use of classroom dialogue in whole-class settings. This study is an initial one that identifies how thinking style moderates the relationship between participation in classroom dialogue and learning outcomes. What is implied for practice is that, the pedagogical approach to styles that I would advocate is one that "acknowledge and celebrates individual diversity" (Evans & Cools, 2011, p. 252). At the individual level, each student should have better self-understanding, especially of their typical ways of thinking (i.e. thinking style), and, based on this, they should choose the most suitable strategy for themselves, either talking or listening, to participate in classroom dialogue. Classroom dialogue is a teaching and learning method widely used in Chinese school contexts. With 50 or more students sharing one lesson, it is impossible to tailor a method or type of instruction in order to match each student's thinking styles. Instead, I suggest that students should maximize their use of classroom dialogue by employing different participatory strategies, either talking or listening. I found that students characterized with the Liberal-Group style preferred to participate in classroom dialogue through talking, while students featuring the Internal-Group style tended to involve in dialogue through listening. Moderation results indicate that, with respect to these two kinds of students, more will achieve good learning outcomes, at least in mathematics, if they are allowed to be involved in dialogue in their preferred ways. Autonomy should be given to these two kinds of students and they should be allowed to choose their own learning. In comparison, students characterized with the Global-group style preferred not to listen in classroom dialogue, but the

moderation results show that they would achieve better mathematics achievement if they are required to listen more. Intervention probably should be provided for this kind of students to help them use different strategies to involve in classroom dialogue. In the long run, students may develop alternative styles in order to adapt to the whole-class learning environment.

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Appendix A. Thinking Style Inventory- Revised II

Sample items from the Thinking Style Inventory- Revised II

Sample items	**Scale type**
I like tasks that allow me to do things in my own way.	Legislative
I like situations in which it is clear what role I must play or in what way I should participate.	Executive
I like to evaluate and compare different points of view on issues that interest me.	Judicial
I like to complete what I am doing before starting something else.	Monarchic
When undertaking some tasks, I like first come up with a list of things that the tasks require me to do and assign an order of priority to the items on the list.	Hierarchical
I usually know what things need to be done, but sometimes have trouble deciding in what order to do them.	Oligarchic
When working on a written project, I usually let my mind wander and my pen follow up on whatever thoughts cross my mind.	Anarchic
Usually when I make a decision, I do not pay much attention to details.	Global
I like problems that require engagement with details.	Local
I like to be alone when working on a problem.	Internal
I like to work with others rather than by myself.	External
I like to do thing in new ways, even if I am not sure they are the best ways.	Liberal
In my work, I like to keep close to what have been done before.	Conservative

Note: I used the Chinese version of Thinking Style Inventory-Revised II, and got the permission from Sternberg and Zhang. However, in order to avoid commercial use, Thinking Style Inventory-Revised II is not allowed to be published. Thus I can merely illustrate 13 sample items with each responding to one thinking style, as above.

Appendix B. Coding scheme for participation in classroom dialogue

Student coding number	Participation frequency				Participation qualify								
	Specific participation forms				Standard level			Cognitive level					
								Assumed-known information		Reasoning			
	TISC	TISNC	TNISC	TNISNC	Incorrect	Partially correct	Correct	Prior knowledge	Personal information	Generalization	Analysis	Speculation	Up-take

Note: TISC= Teacher initiates a dialogue and student contributes a response; TISNC= Teacher initiates a dialogue and student does not contribute a response even though he/she shows an intention; TNISC= Teacher does not initiates a dialogue but student contributes a comment or ask a question; TNISNC= Teacher does not initiate a dialogue but student shows an intention to talk even though he/she does not have an opportunity to contribute.

Appendix C. Questionnaire for performance in classroom dialogue

Class

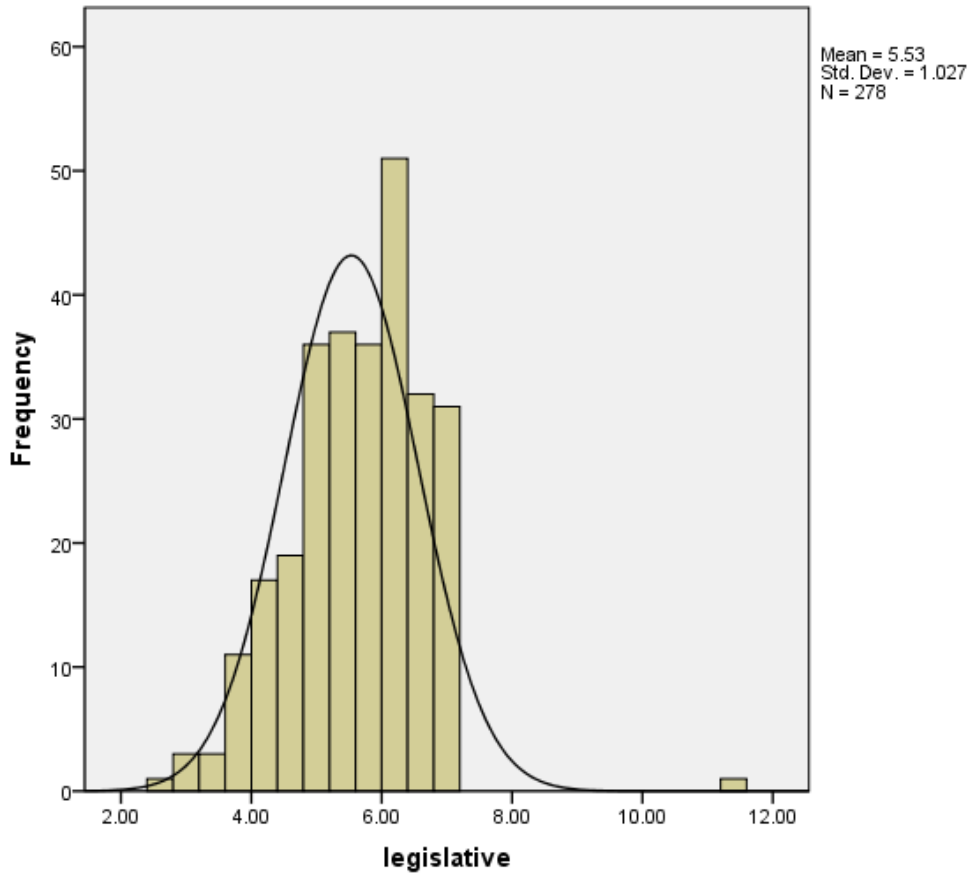
Gender: Male/Female

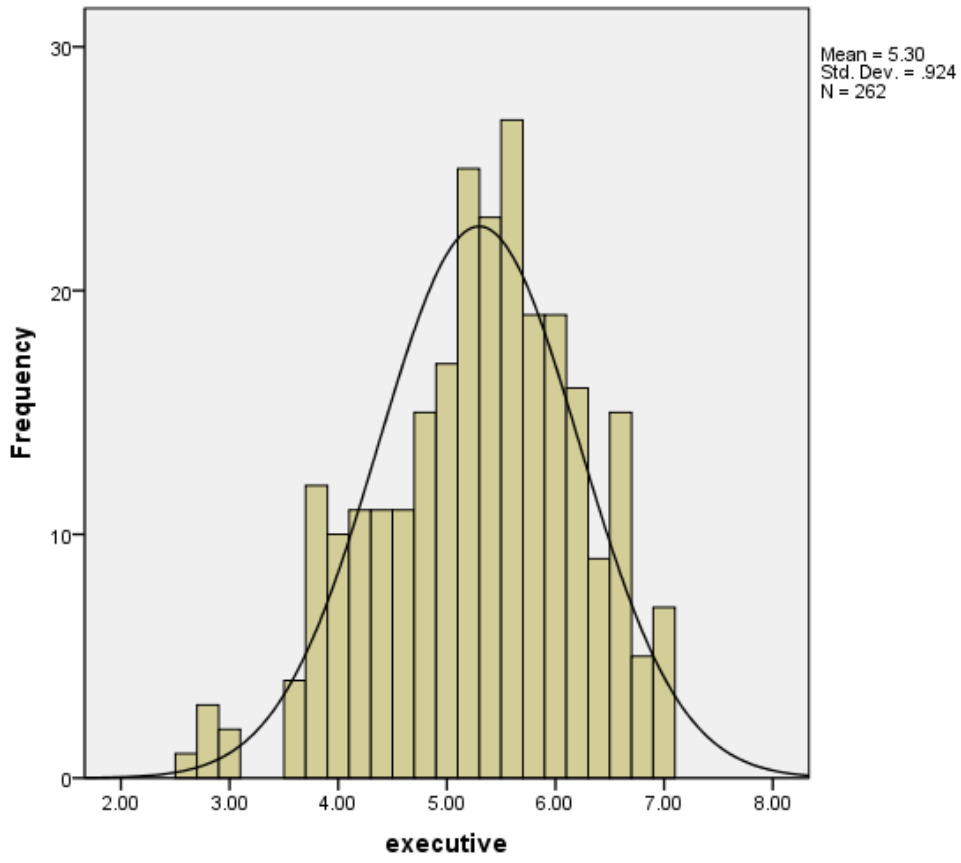
	Never	Seldom	Sometimes	Often	Always
Participation frequency					
1. I listen to the teacher's instructions.					
2. I listen to other students' speaking when they answer questions.					
3. I listen to other students' discussion.					
4. I do not day dream during class.					
5. I take notes while I am listening in class.					
Participation quality					
6. In the class, I feel uncomfortable when I answer questions.					
7. In the class, I feel uncomfortable when I discuss with other students publicly.					
8. In the class, I feel uncomfortable when I ask questions.					
9. In the class, I feel comfortable when I remain silent to listen to others students' speaking.					
10. In the class, I feel comfortable when I remain silent to listen to the teacher's instructions.					
11. I memorize knowledge better when I remain attentively silent compared to talk in classroom dialogue.					
12. I think more critically when I remain attentively silent compared to talk in classroom dialogue.					
13, I solve problems better when I remain attentively silent compared to talk in classroom dialogue.					
14. I come up with more creative ideas when I remain attentively silent compared to talk in classroom dialogue.					
15. I apply existing knowledge to solve novel problems better when I remain attentively silent compared to talk in classroom dialogue.					

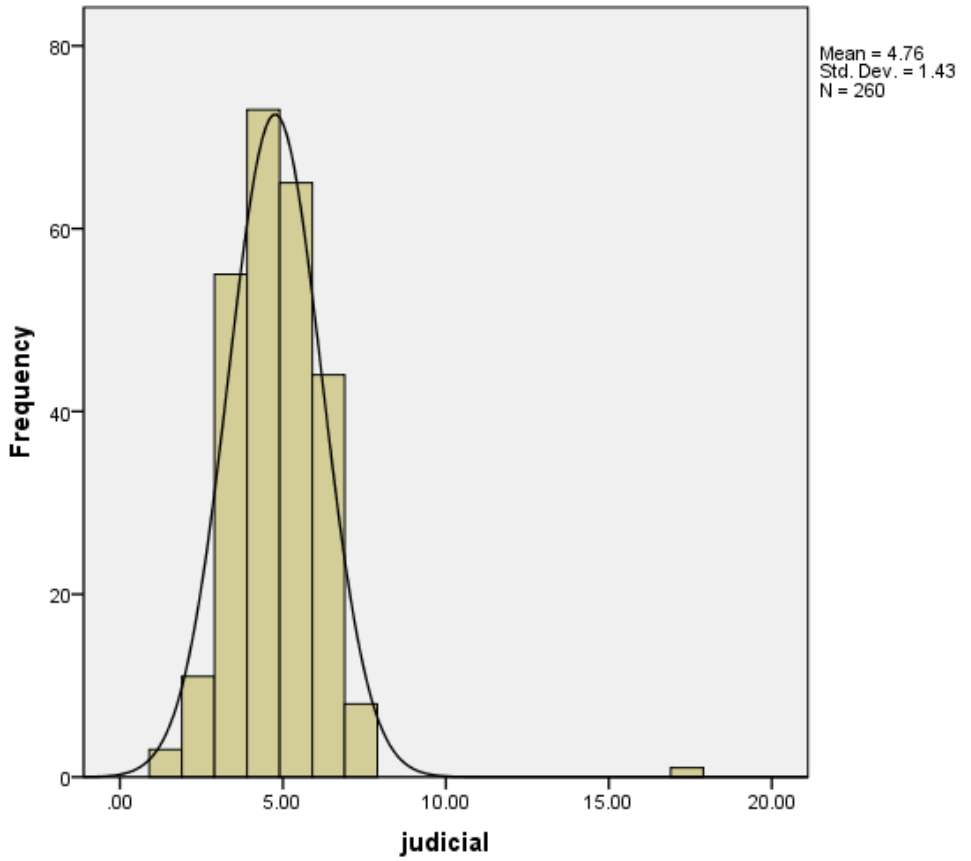
Appendix D Sample tests in the Sternberg Triarchic Ability Test

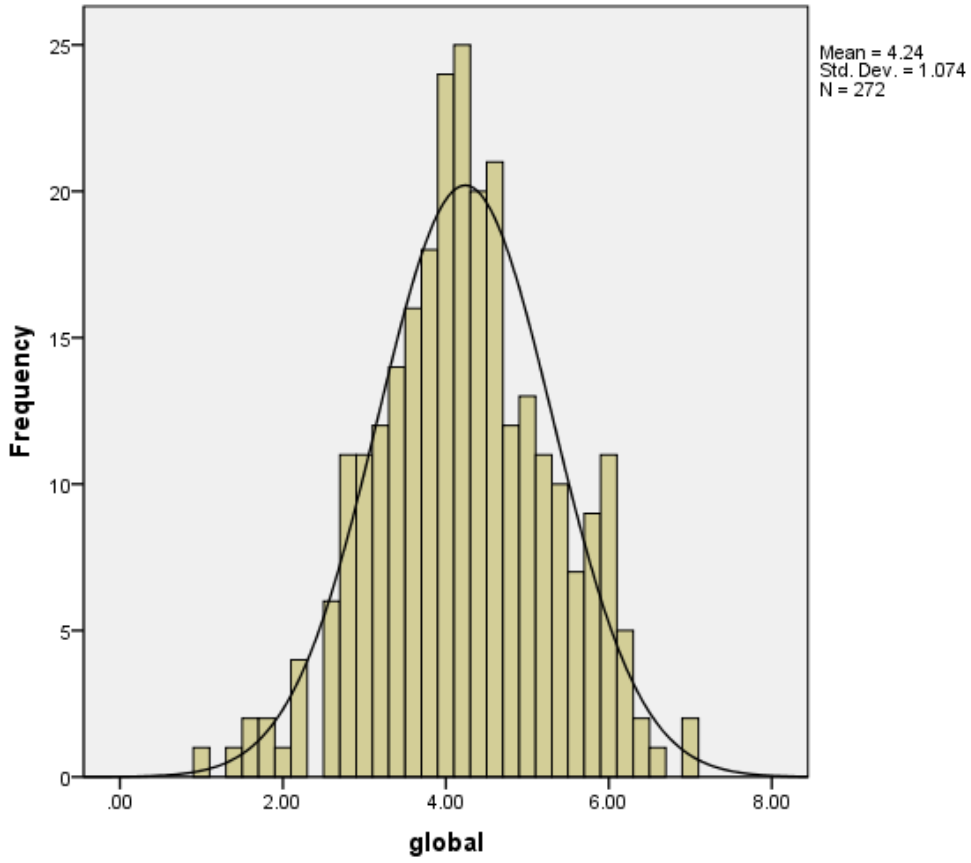
Scales	**Sample tests**
Analytical-verbal	Students see a novel word embedded in a paragraph, and have to infer its meaning from the context.
Analytical-quantitative	Students have to say what number should come next in a series of numbers.
Analytical-figural	Students see a figural matrix with the lower right entry missing, and have to say which of the options fits into the space.
Creative-verbal	Students are presented with verbal analogies preceded by counterfactual premises (e.g., money falls off trees), and must solve the analogies as though the counterfactual premises were true.
Creative-quantitative	Students are presented with rules for novel number operations (e.g., *flix*, for which numerical manipulations differ depending upon whether the first of two operands is greater than, equal to, or less than the second). Students have to use the novel number operations to solve presented mathematical problems.
Creative-figural	Students are first presented with a figural series that involves one or more transformations; then they must apply the rule of the original series to a new figure with a different appearance, to complete a new series.
Practical-verbal	Students have to solve a set of everyday problems in the life of an adolescent (e.g., what to do about a friend who seems to have a substance-abuse problem)
Practical-quantitative	Students have to solve math problems based on scenarios requiring the use of mathematics in everyday life (e.g., buying tickets for a ballgame or making chocolate chip cookies).
Practical-figural	Students are presented with a map of an area (e.g., an entertainment park), and have to answer questions about navigating effectively through the area depicted by the map.

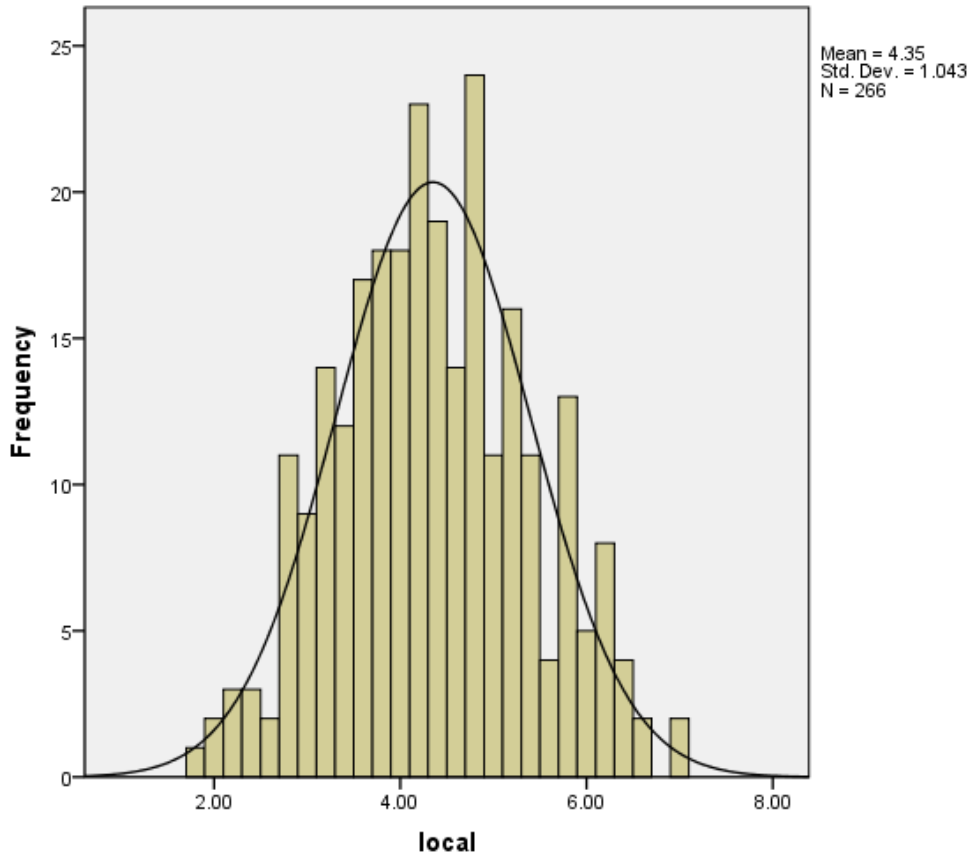
Appendix E. Histograms and normal distributed curves for thinking style

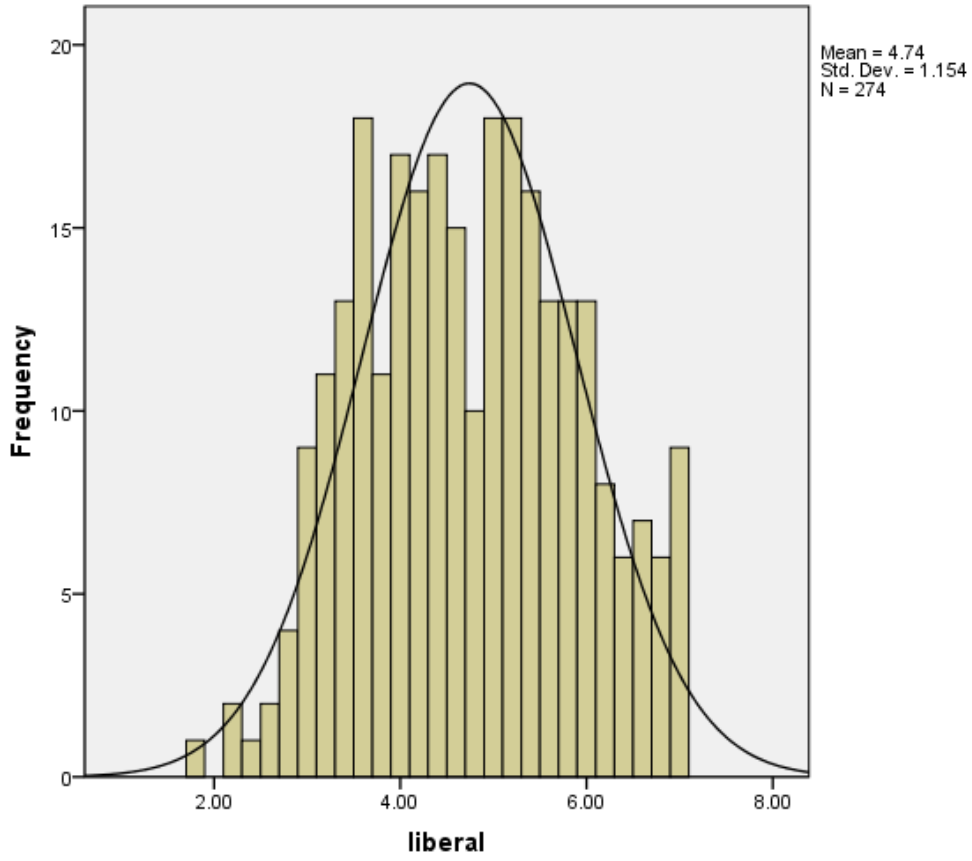


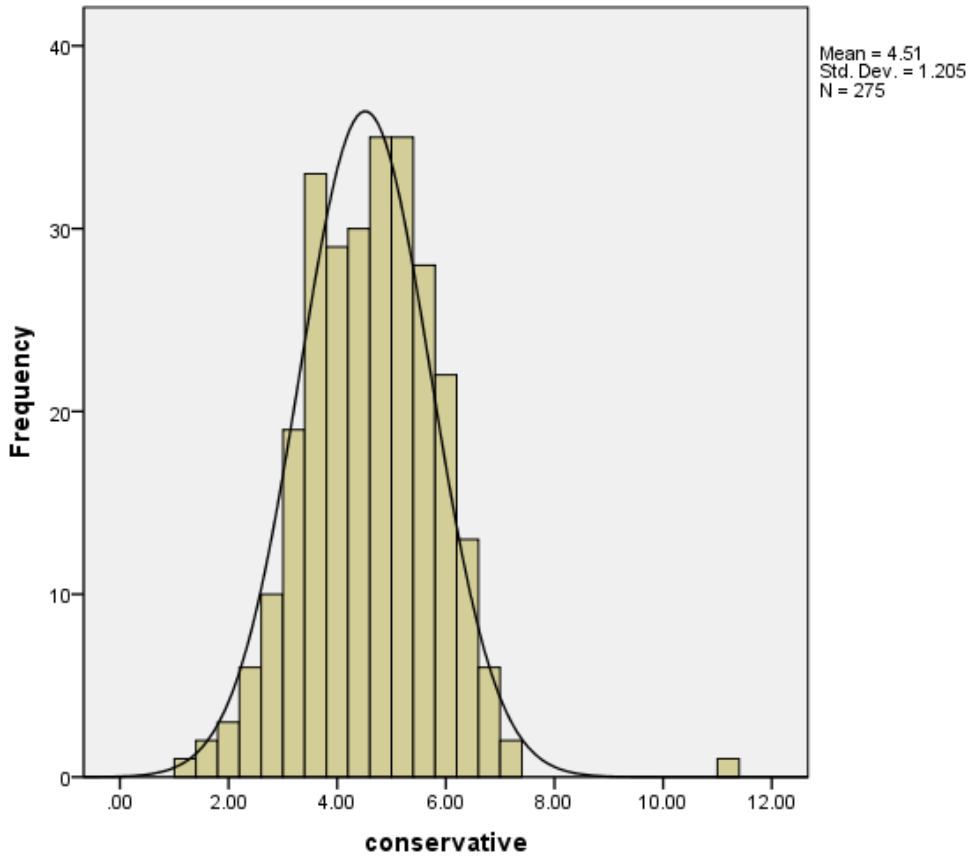


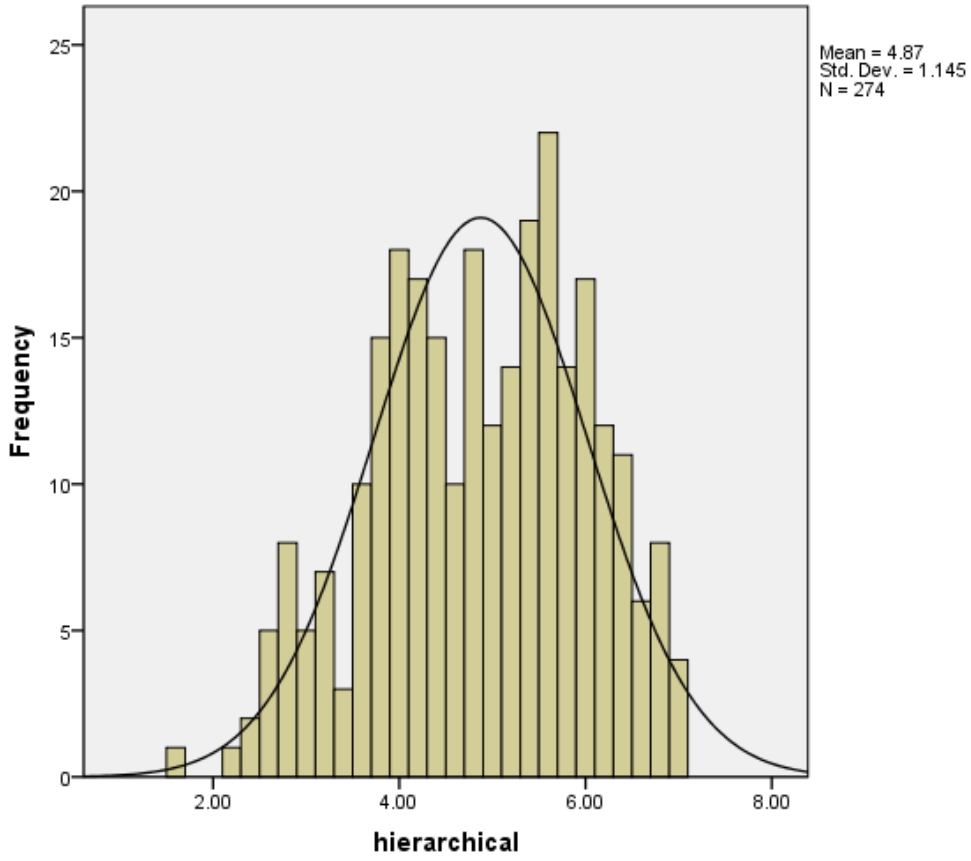

Mean = 4.76
Std. Dev. = 1.43
N = 260
Frequency
judicial
0
20
40
60
80
.00
5.00
10.00
15.00
20.00

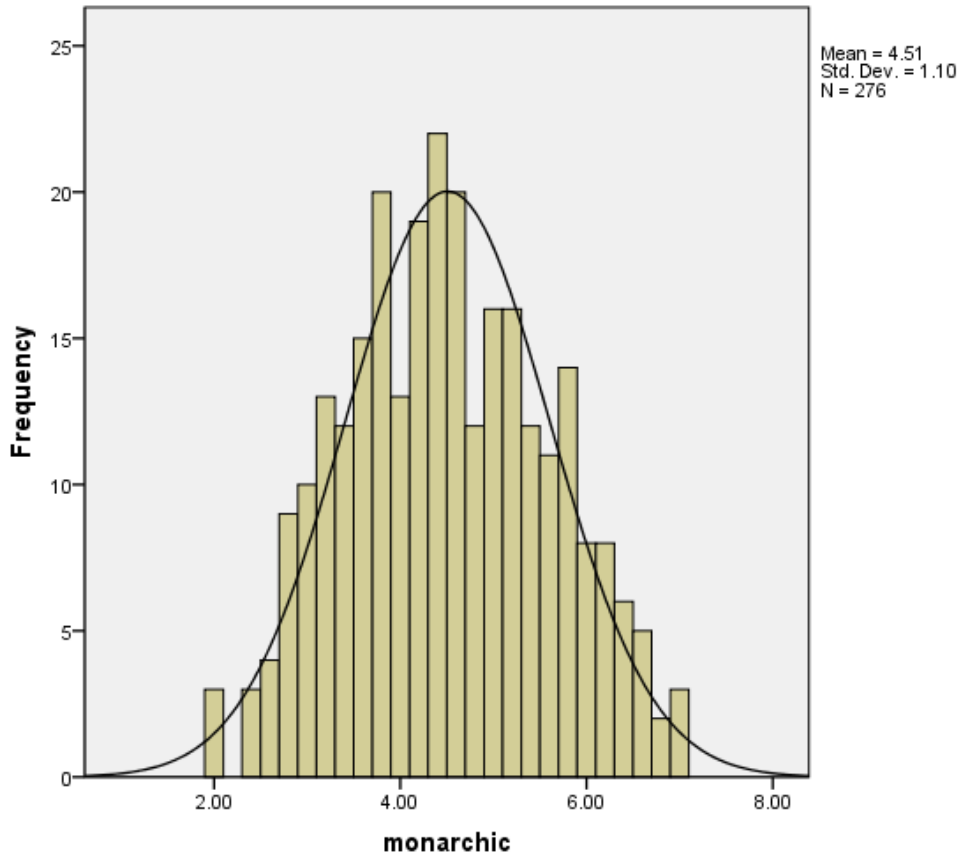

Mean = 4.24
Std. Dev. = 1.074
N = 272
Frequency
global
0
5
10
15
20
25
.00
2.00
4.00
6.00
8.00

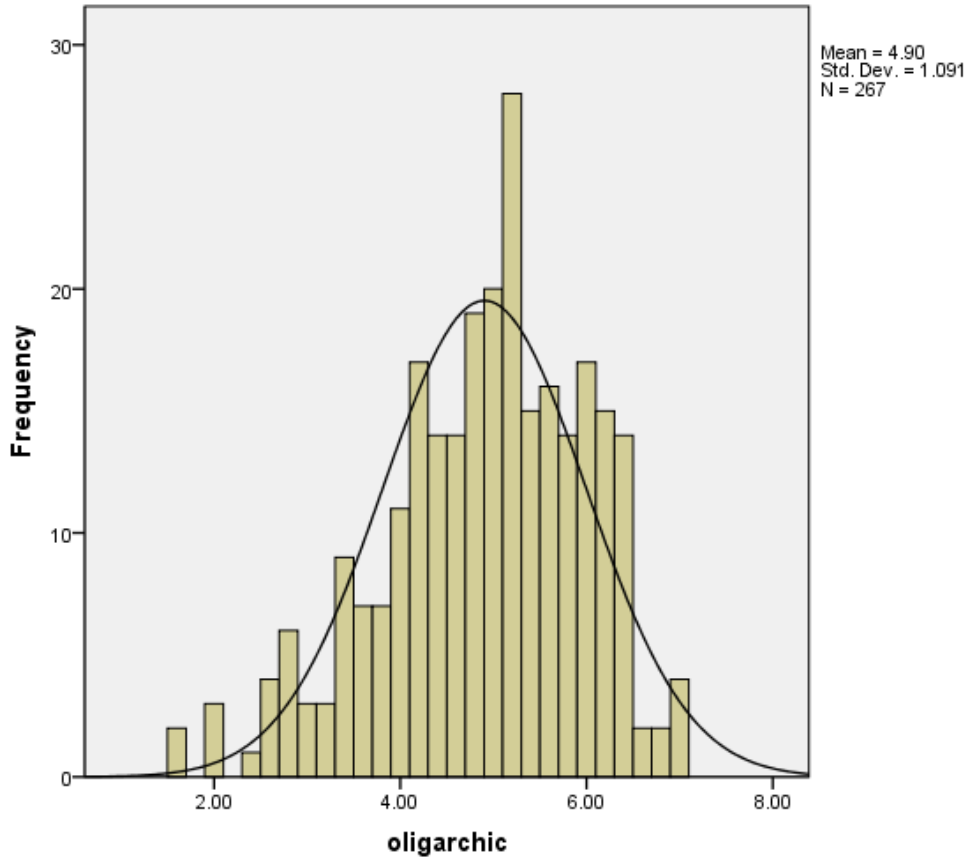

Mean = 4.35
Std. Dev. = 1.043
N = 266
Frequency
25
20
15
10
5
0
2.00
4.00
6.00
8.00
local

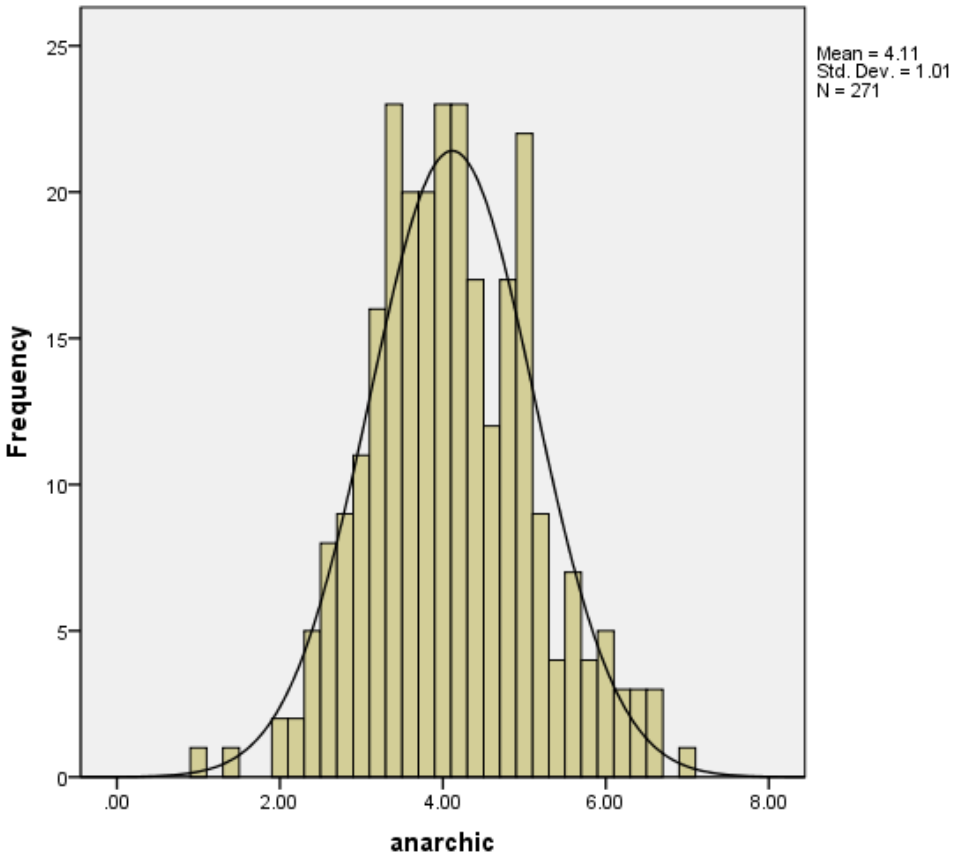

Mean = 4.74
Std. Dev. = 1.154
N = 274
Frequency
20
15
10
5
0
2.00
4.00
6.00
8.00
liberal

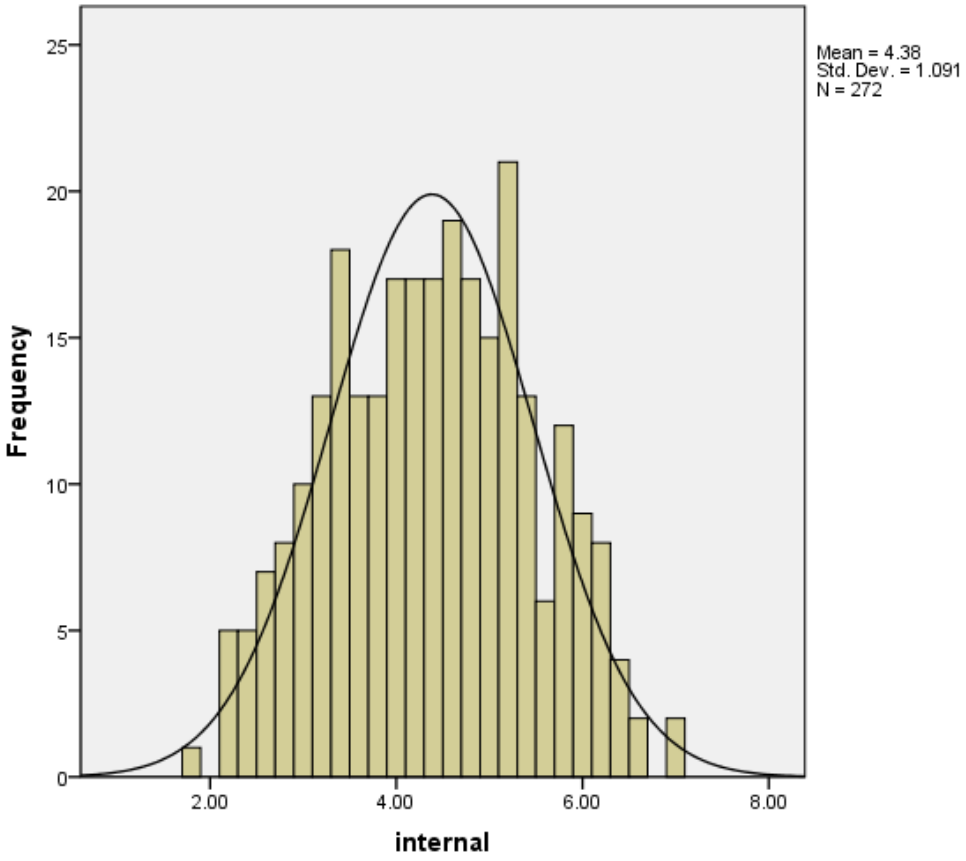

Mean = 4.51
Std. Dev. = 1.205
N = 275
Frequency
conservative
0
10
20
30
40
.00
2.00
4.00
6.00
8.00
10.00
12.00

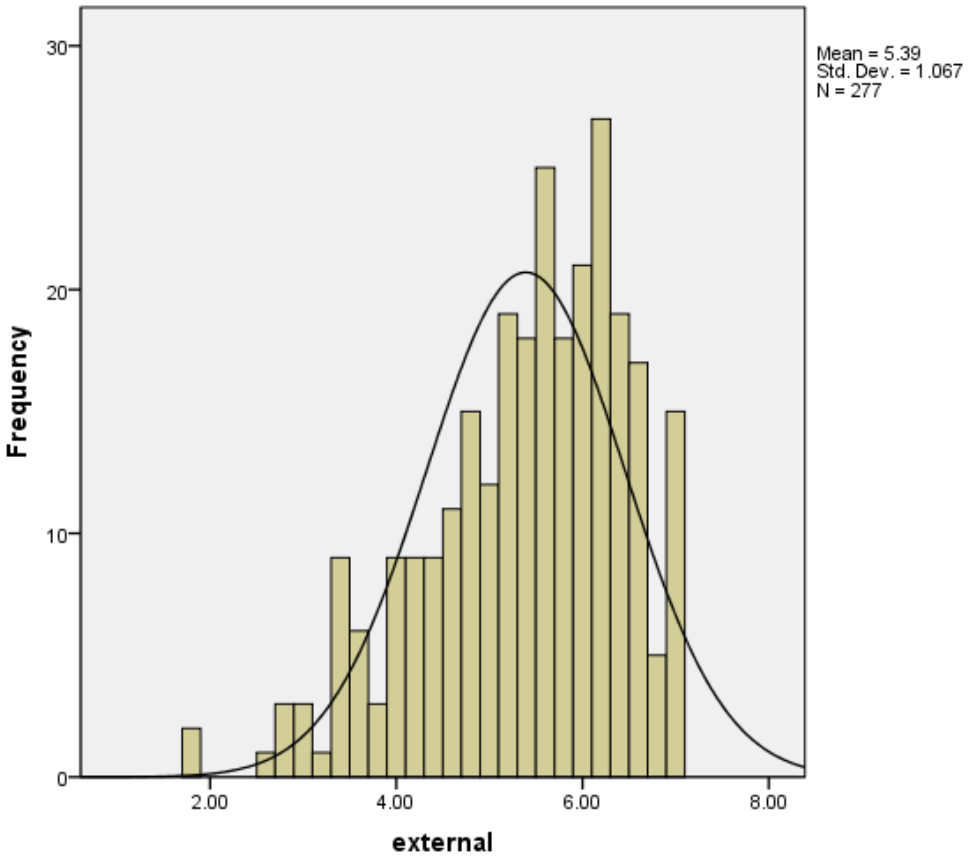

Mean = 4.87
Std. Dev. = 1.145
N = 274
Frequency
hierarchical
0
5
10
15
20
25
2.00
4.00
6.00
8.00


Mean = 4.51
Std. Dev. = 1.10
N = 276
Frequency
25
20
15
10
5
0
2.00
4.00
6.00
8.00
monarchic

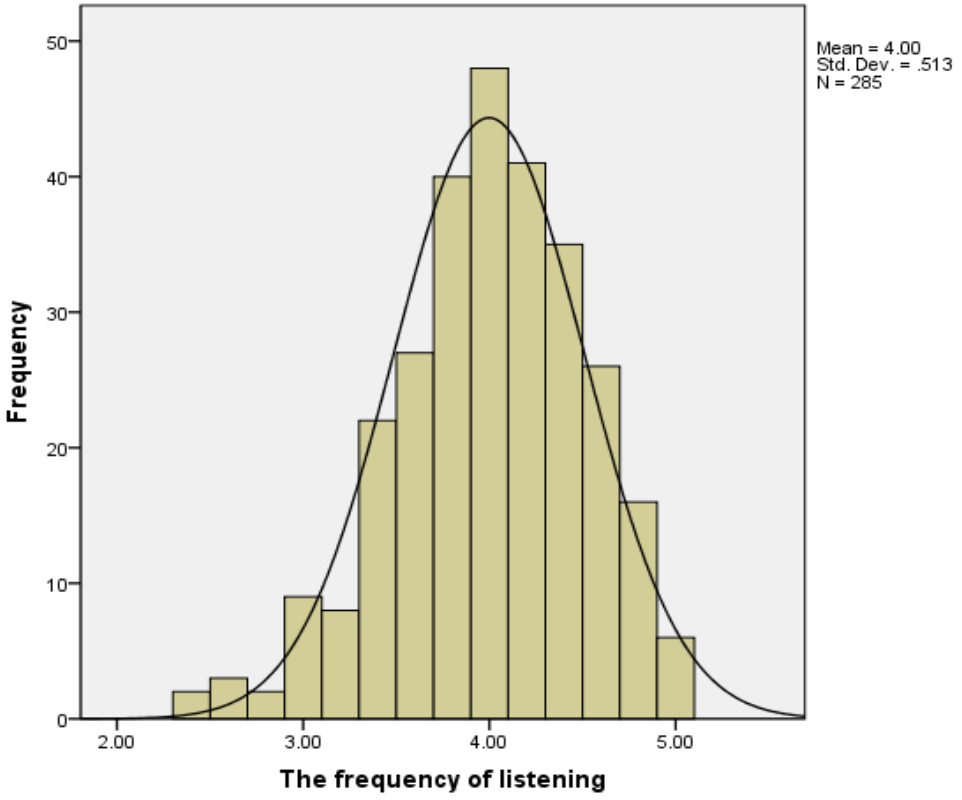

Mean = 4.90
Std. Dev. = 1.091
N = 267
Frequency
30
20
10
0
2.00
4.00
6.00
8.00
oligarchic

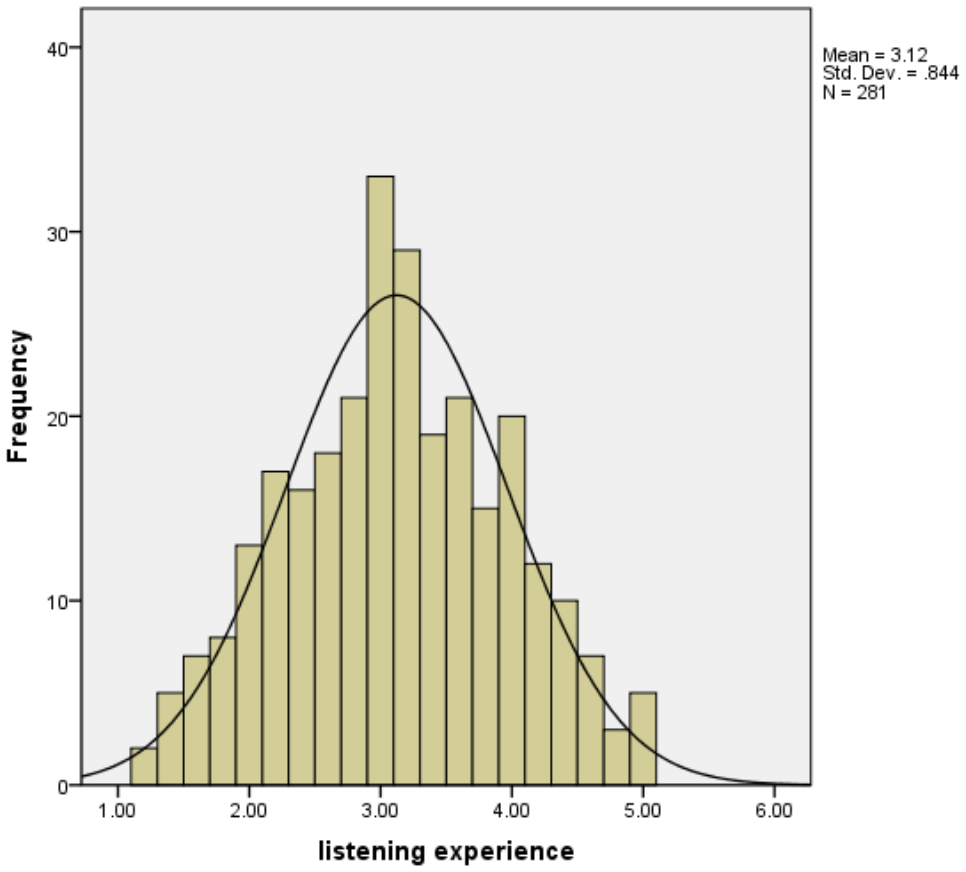

Mean = 4.11
Std. Dev. = 1.01
N = 271
Frequency
anarchic
0
5
10
15
20
25
.00
2.00
4.00
6.00
8.00

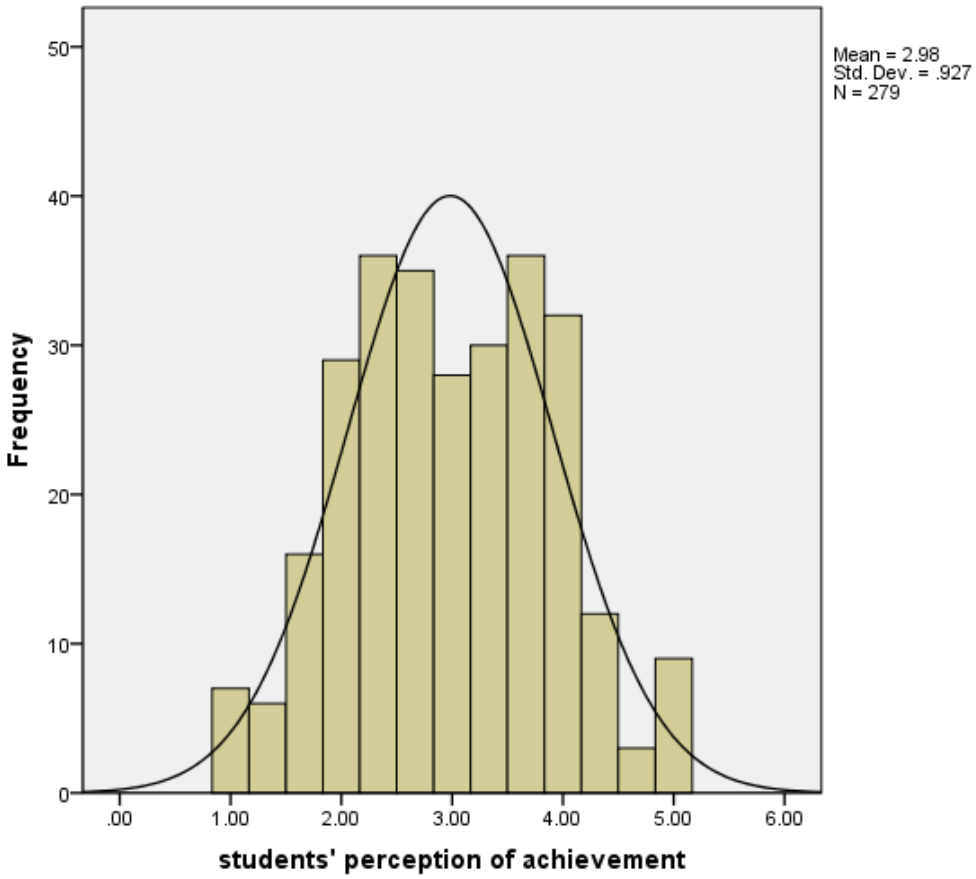

Mean = 4.38
Std. Dev. = 1.091
N = 272
Frequency
internal
0
5
10
15
20
25
2.00
4.00
6.00
8.00

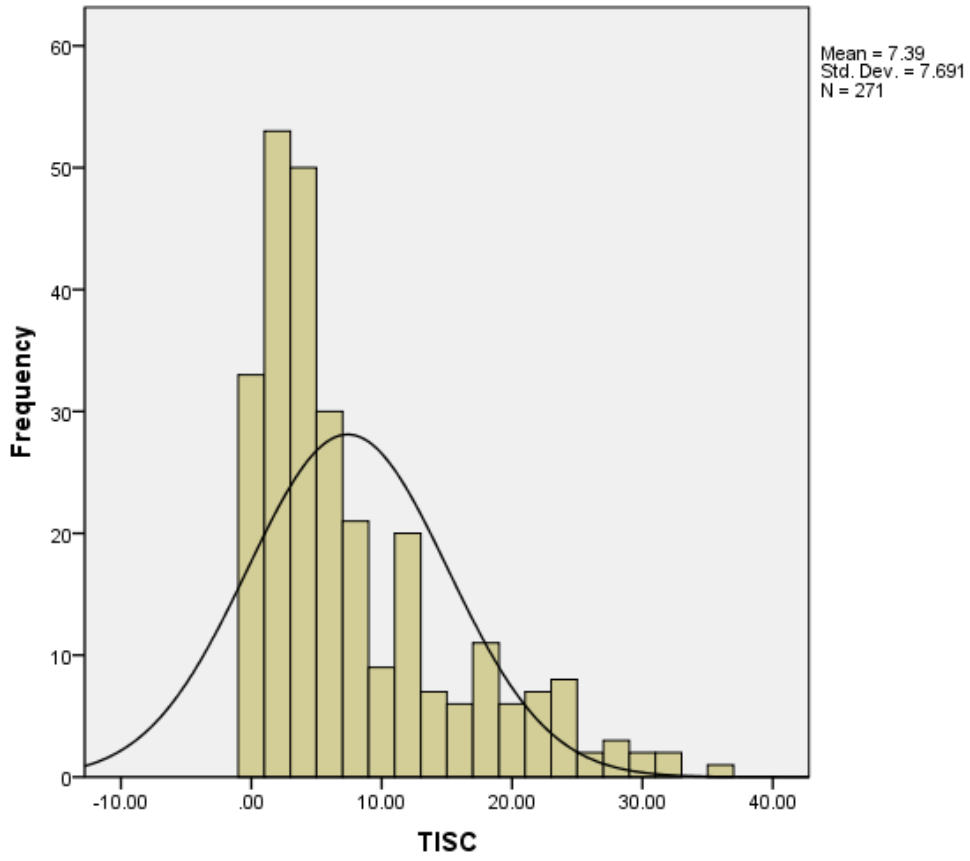

Mean = 5.39
Std. Dev. = 1.067
N = 277
Frequency
30
20
10
0
2.00
4.00
6.00
8.00
external

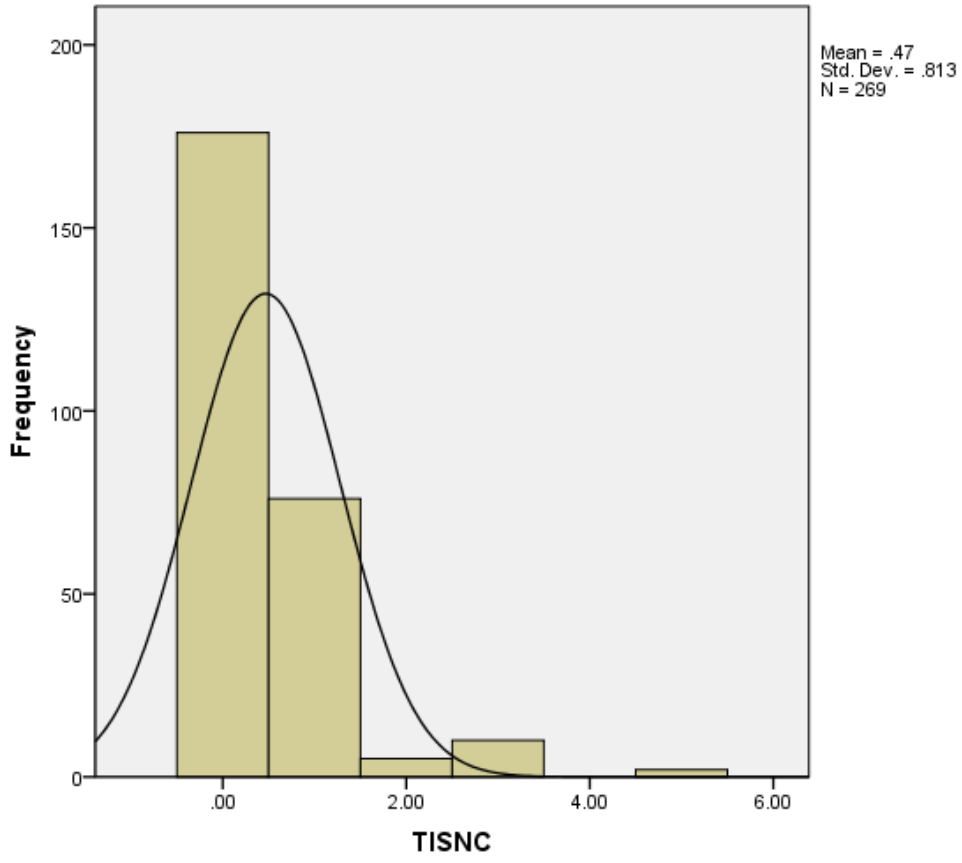
Appendix F. Histograms and normal distributed curves for participation

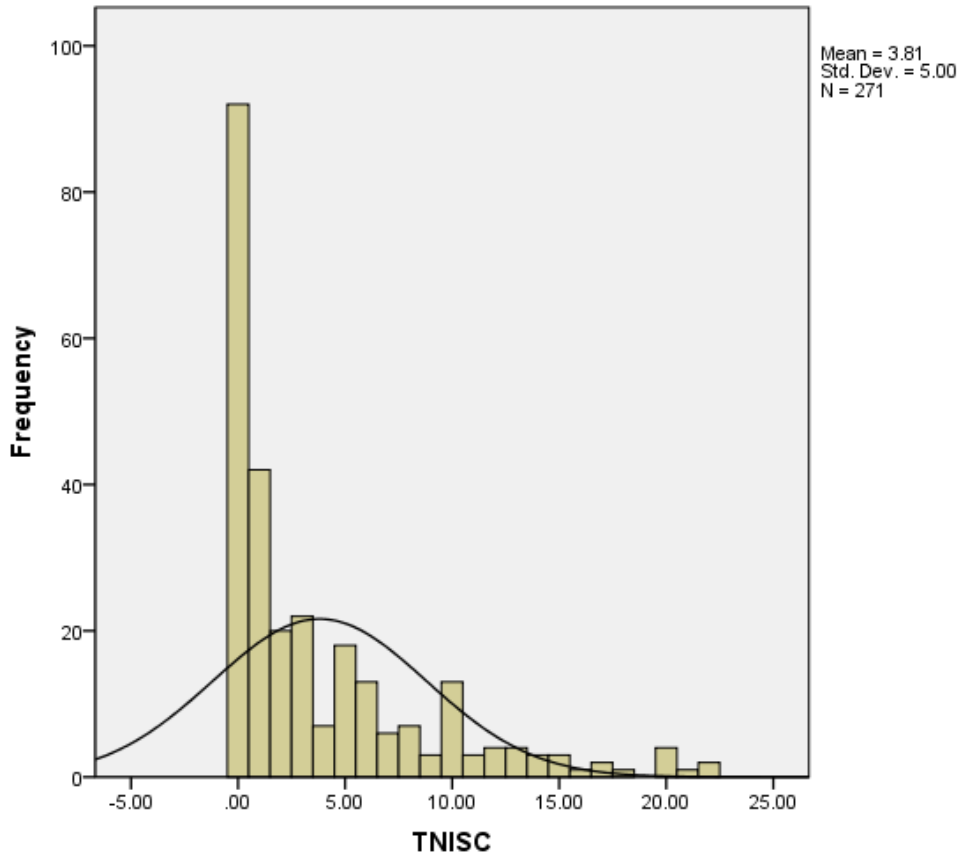


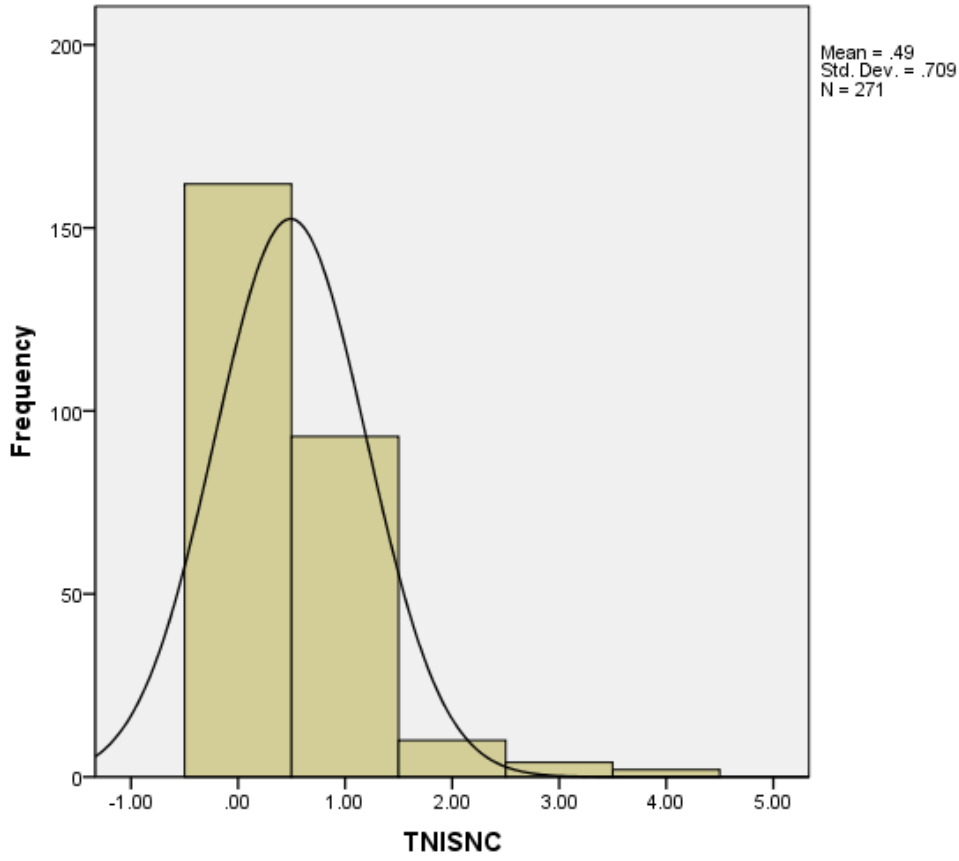


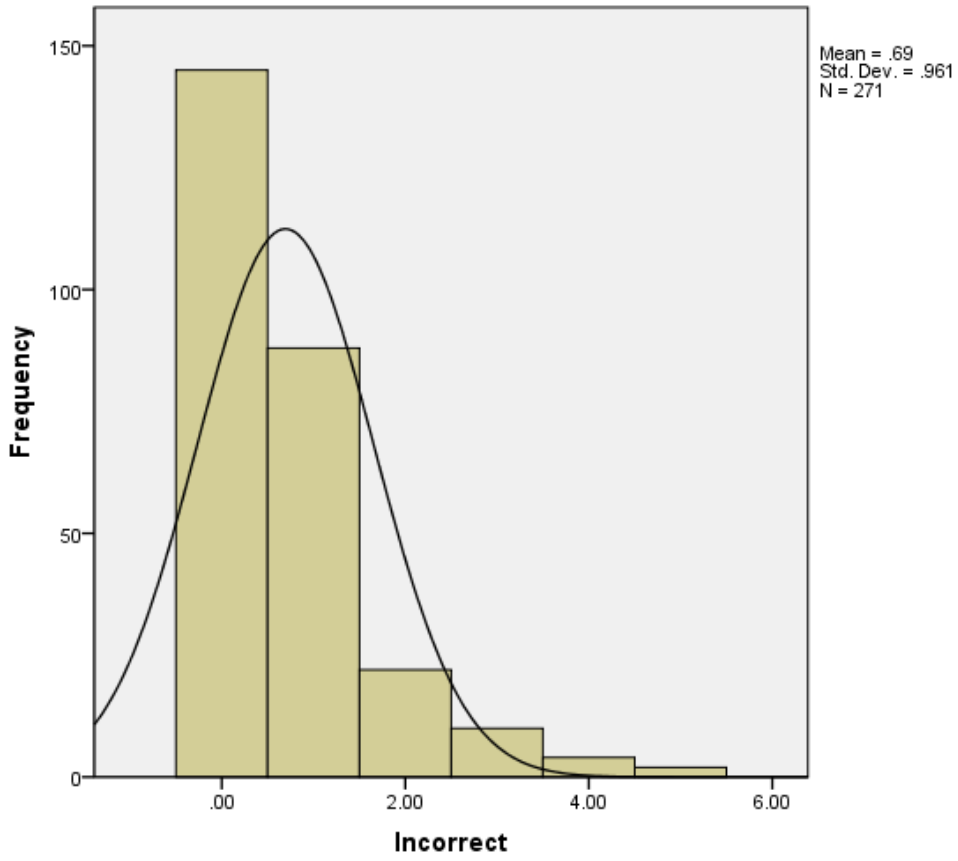

Mean = 2.98
Std. Dev. = .927
N = 279
Frequency
50
40
30
20
10
0
.00
1.00
2.00
3.00
4.00
5.00
6.00
students' perception of achievement

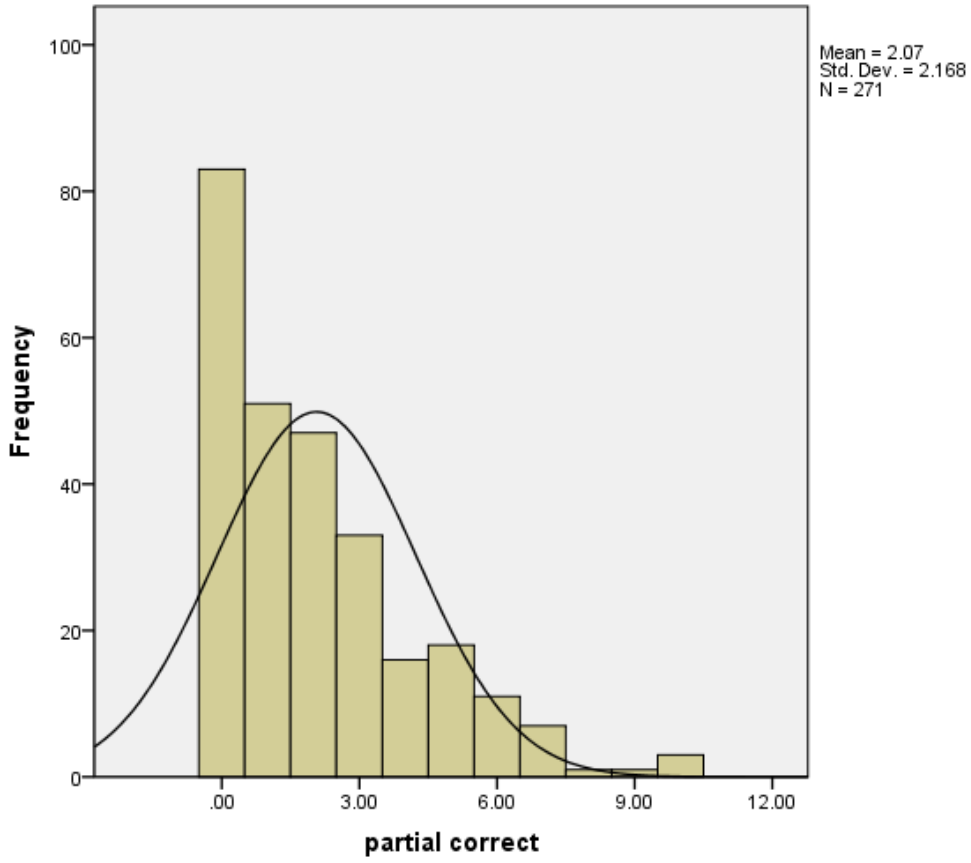

Mean = 7.39
Std. Dev. = 7.691
N = 271
Frequency
TISC
60
50
40
30
20
10
0
-10.00
.00
10.00
20.00
30.00
40.00

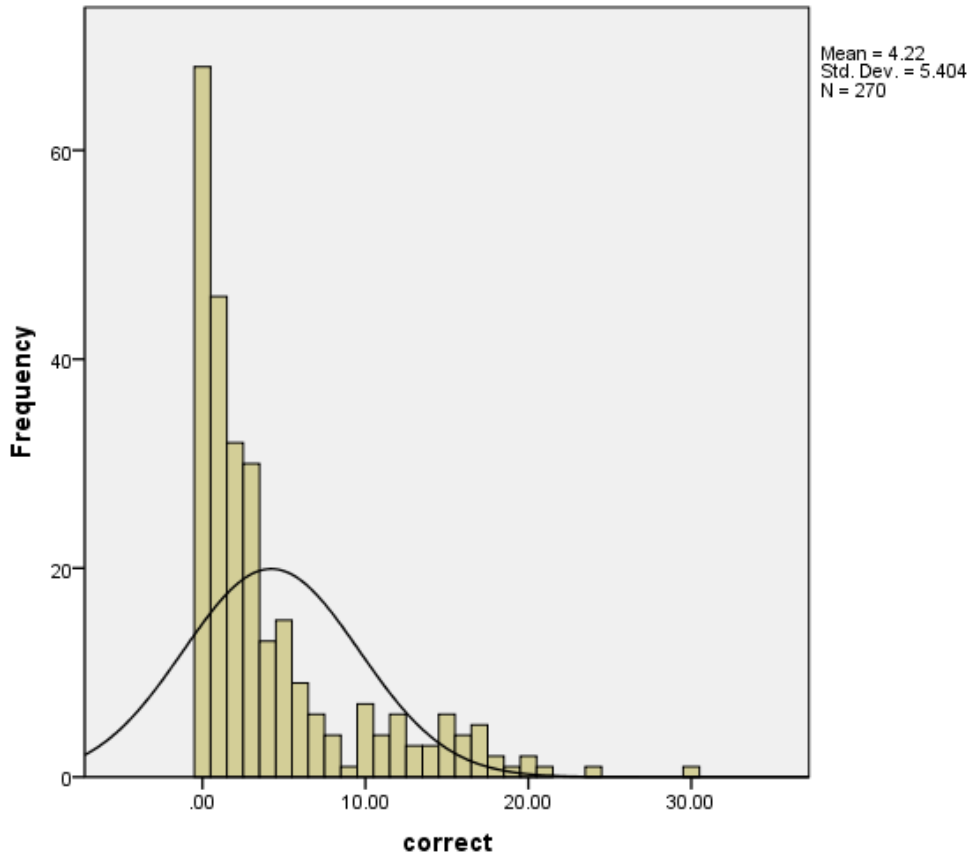

Mean = .47
Std. Dev. = .813
N = 269
Frequency
TISNC
200
150
100
50
0
.00
2.00
4.00
6.00

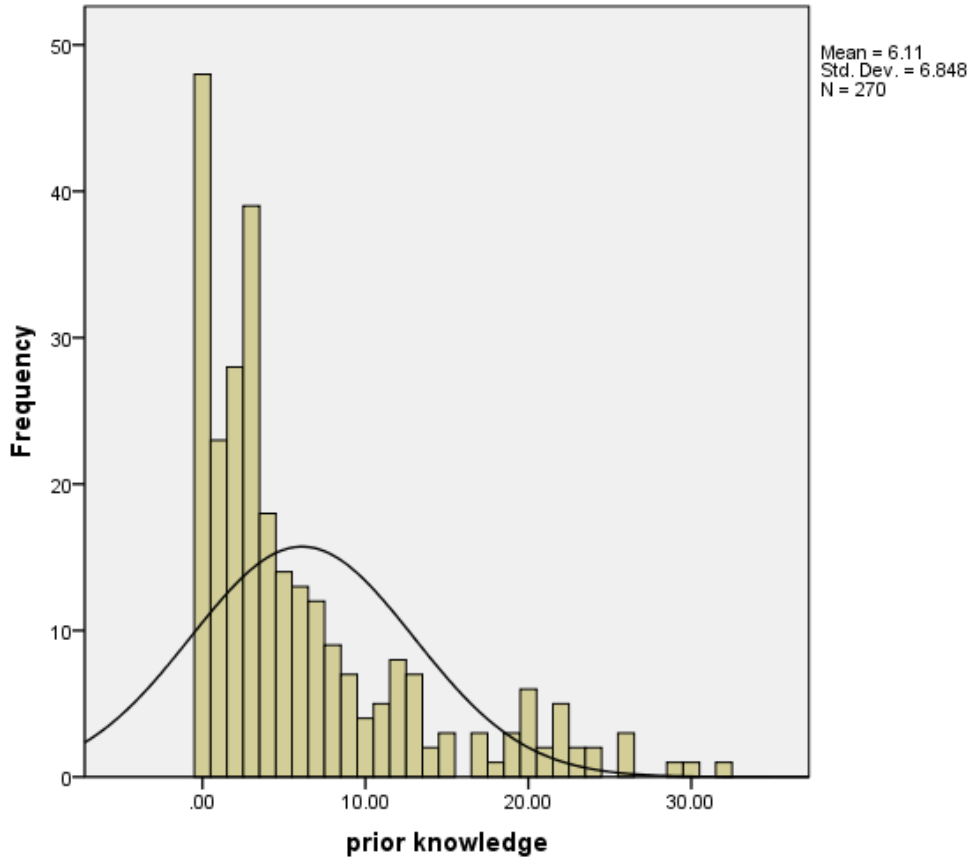

Mean = 3.81
Std. Dev. = 5.00
N = 271
Frequency
100
80
60
40
20
0
-5.00
.00
5.00
10.00
15.00
20.00
25.00
TNISC

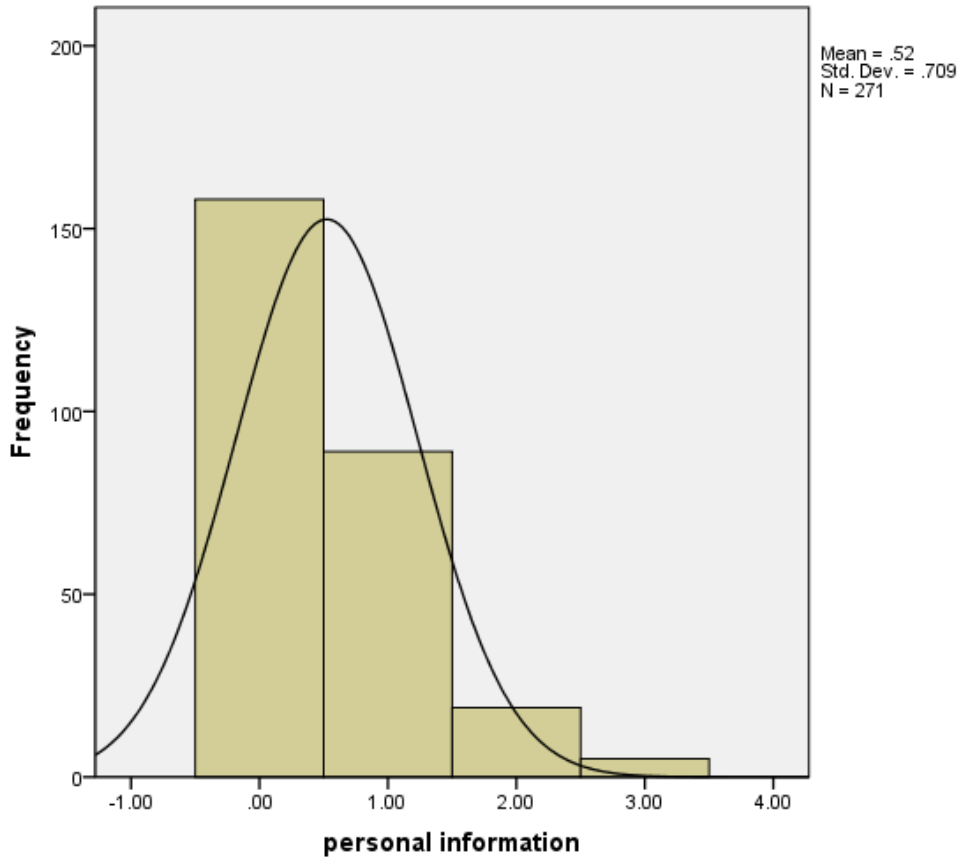

Mean = .49
Std. Dev. = .709
N = 271
Frequency
200
150
100
50
0
-1.00
.00
1.00
2.00
3.00
4.00
5.00
TNISNC

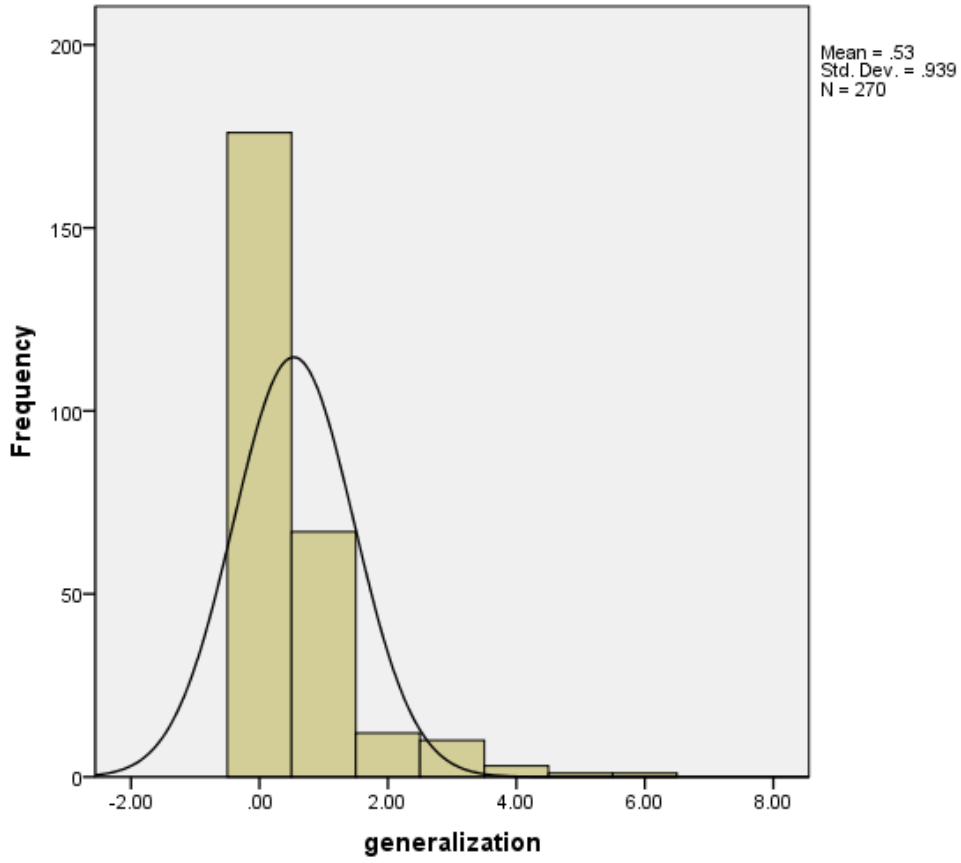

Mean = .69
Std. Dev. = .961
N = 271
Frequency
150
100
50
0
.00
2.00
4.00
6.00
Incorrect

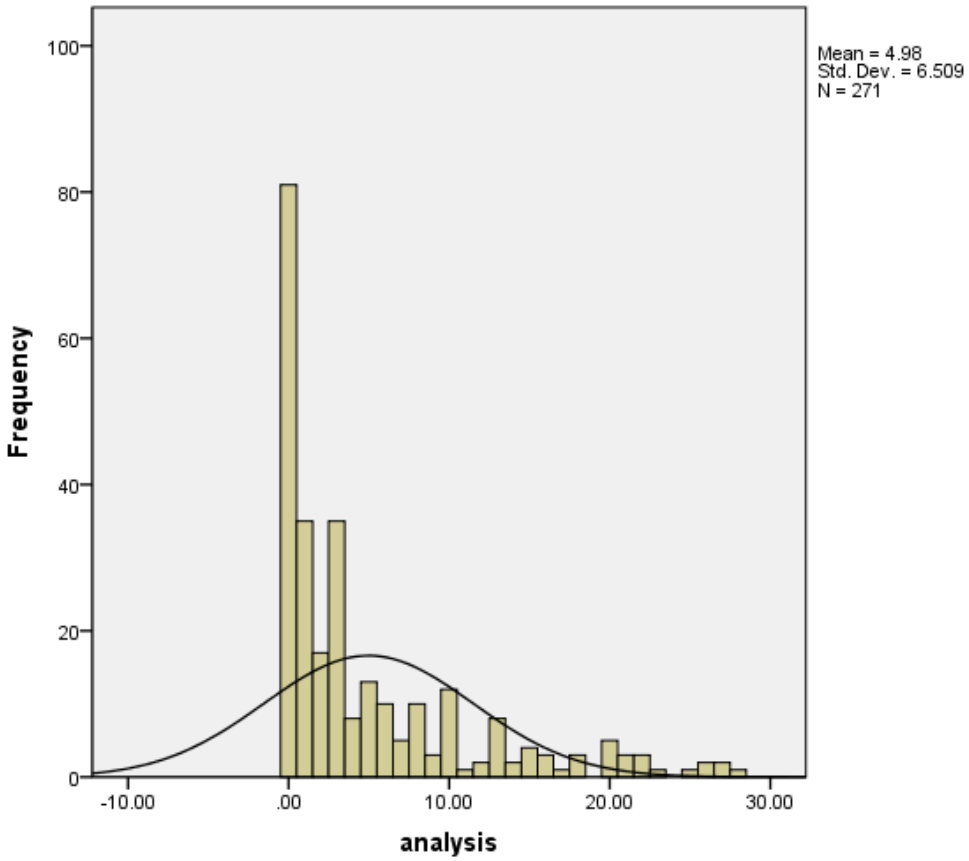

Mean = 2.07
Std. Dev. = 2.168
N = 271
Frequency
100
80
60
40
20
0
.00
3.00
6.00
9.00
12.00
partial correct

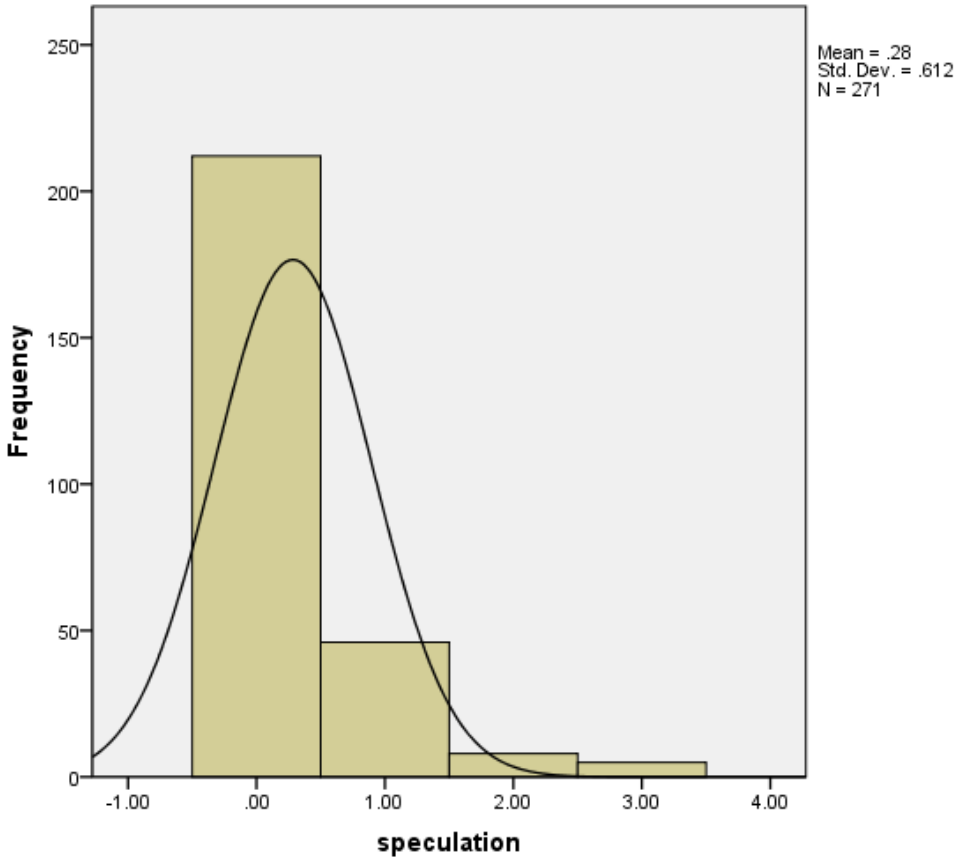

Mean = 4.22
Std. Dev. = 5.404
N = 270
Frequency
60
40
20
0
.00
10.00
20.00
30.00
correct

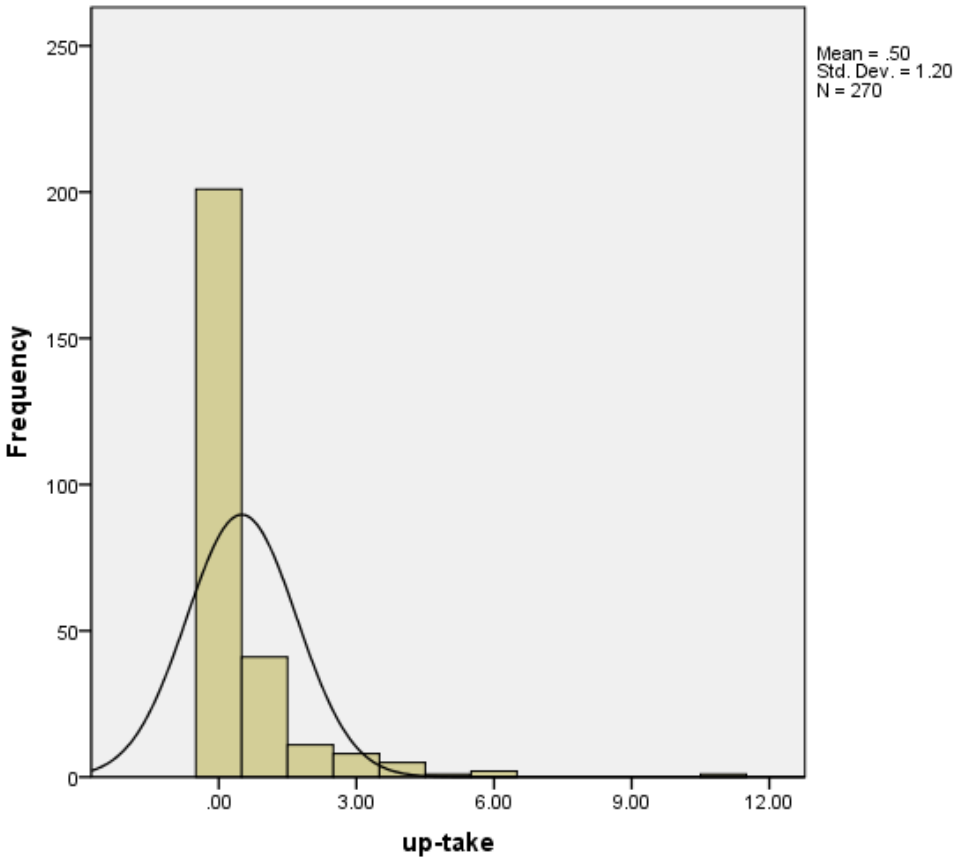

Mean = 6.11
Std. Dev. = 6.848
N = 270
Frequency
50
40
30
20
10
0
.00
10.00
20.00
30.00
prior knowledge

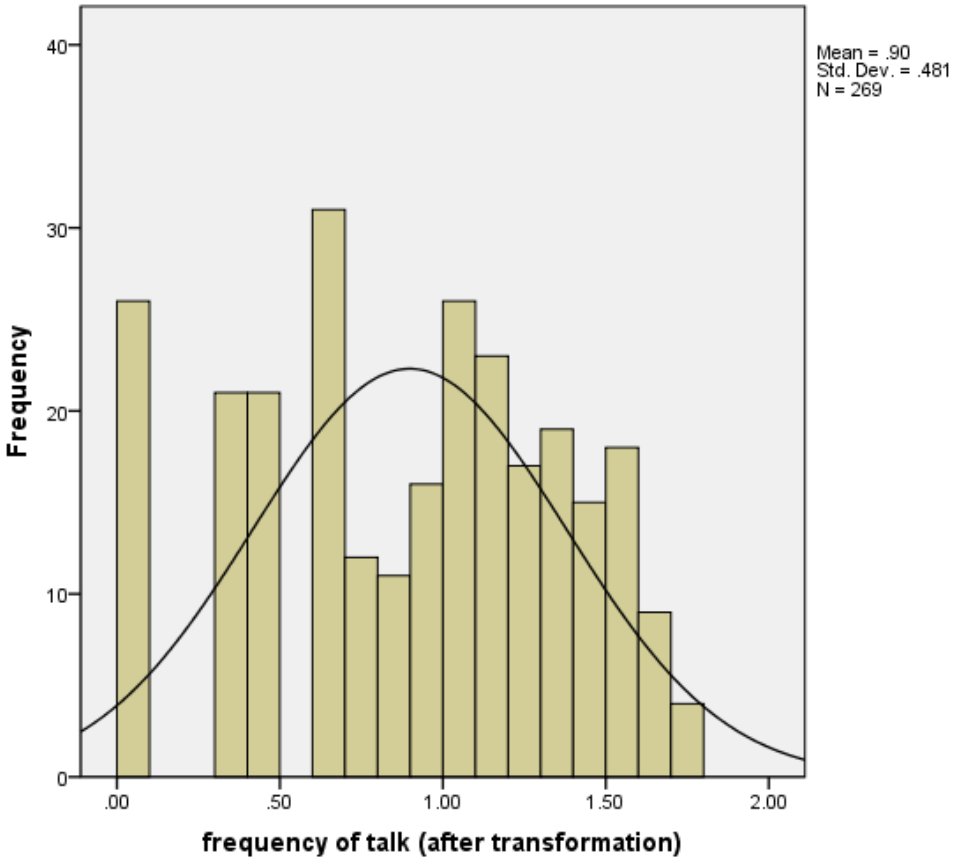

Mean = .52
Std. Dev. = .709
N = 271
Frequency
200
150
100
50
0
-1.00
.00
1.00
2.00
3.00
4.00
personal information

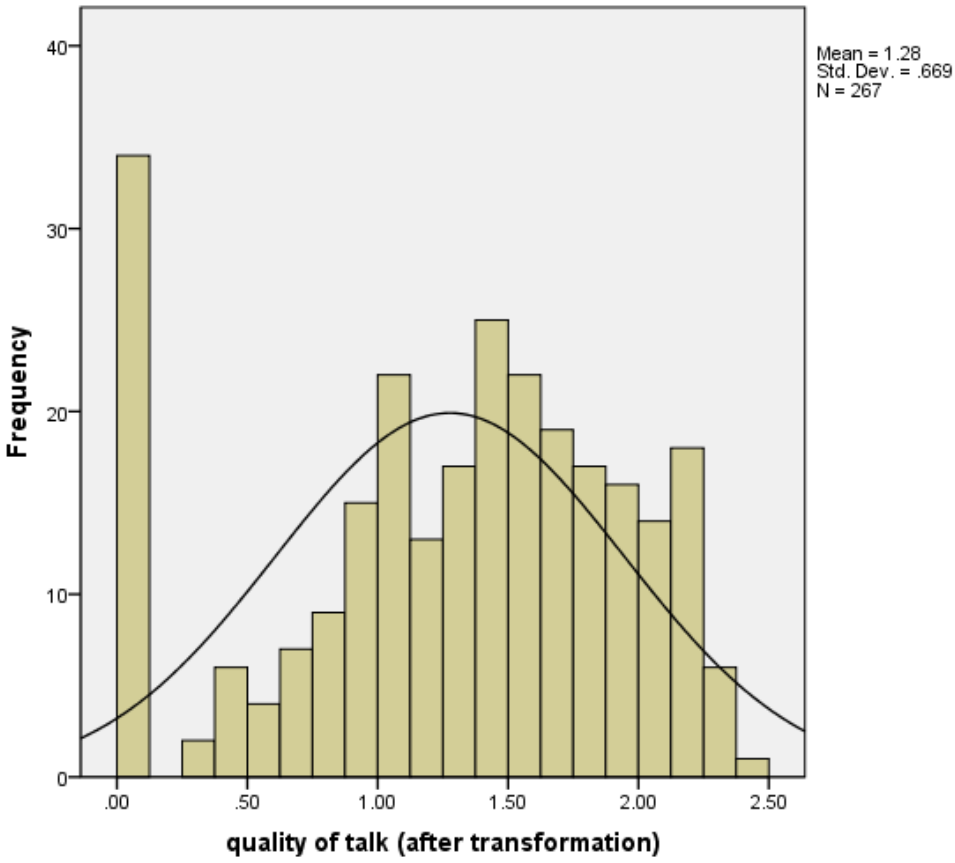

Mean = .53
Std. Dev. = .939
N = 270
Frequency
200
150
100
50
0
-2.00
.00
2.00
4.00
6.00
8.00
generalization


Mean = 4.98
Std. Dev. = 6.509
N = 271
Frequency
100
80
60
40
20
0
-10.00
.00
10.00
20.00
30.00
analysis

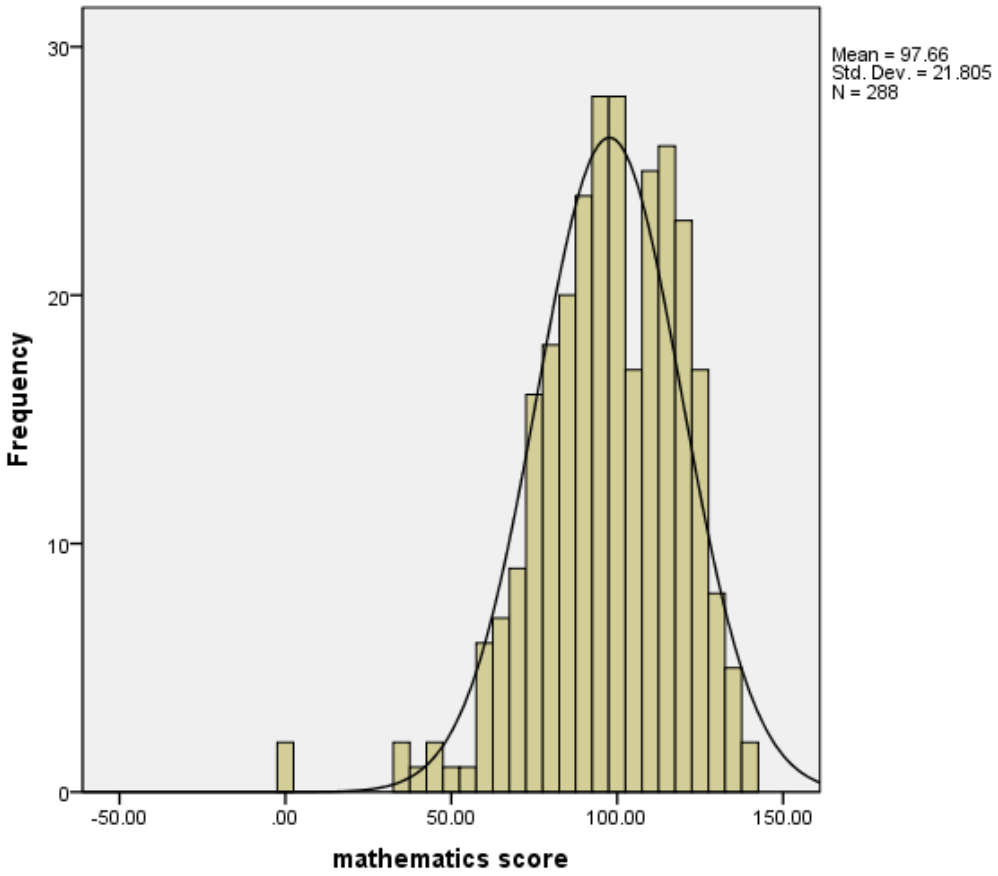

Mean = .28
Std. Dev. = .612
N = 271
Frequency
250
200
150
100
50
0
-1.00
.00
1.00
2.00
3.00
4.00
speculation

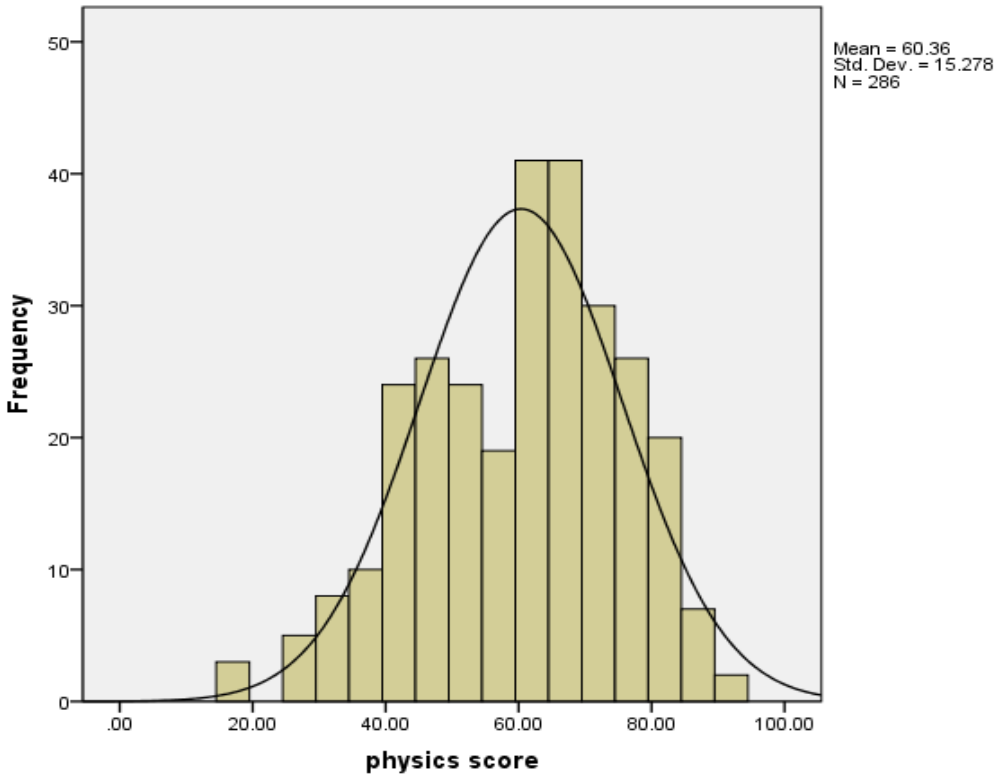

Mean = .50
Std. Dev. = 1.20
N = 270
Frequency
250
200
150
100
50
0
.00
3.00
6.00
9.00
12.00
up-take

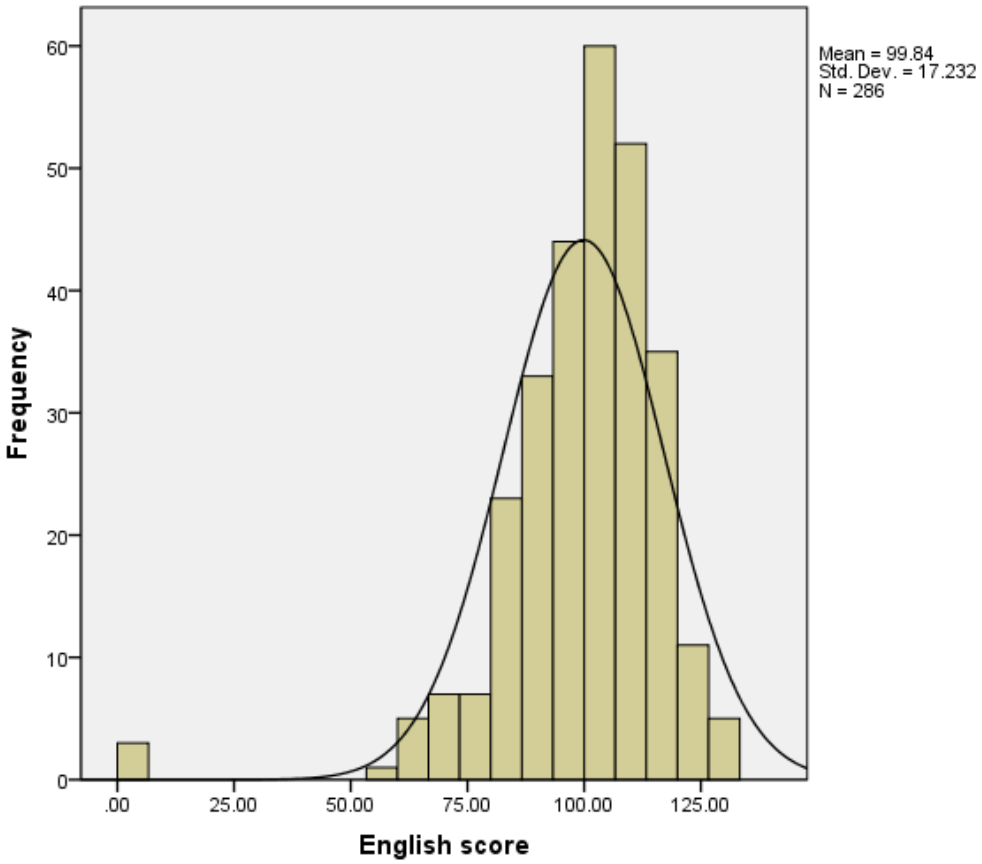

Mean = .90
Std. Dev. = .481
N = 269
Frequency
40
30
20
10
0
.00
.50
1.00
1.50
2.00
frequency of talk (after transformation)

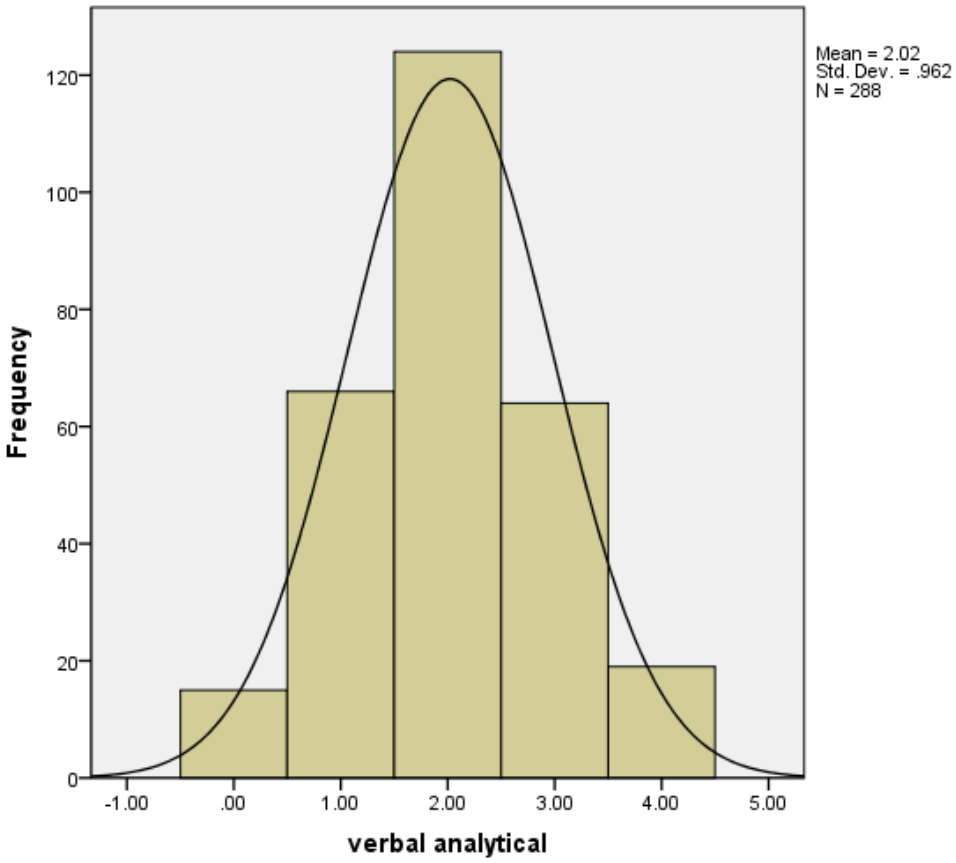

Mean = 1.28
Std. Dev. = .669
N = 267
Frequency
40
30
20
10
0
.00
.50
1.00
1.50
2.00
2.50
quality of talk (after transformation)

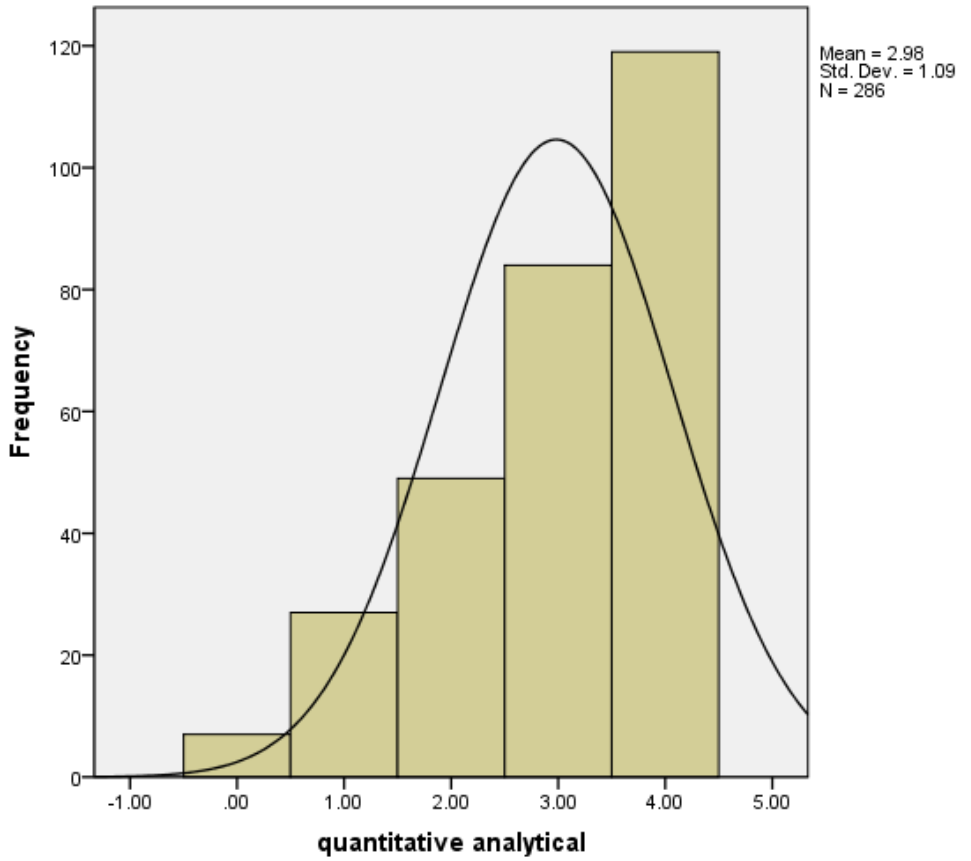
Appendix G. Histograms and normal distributed curves for abilities

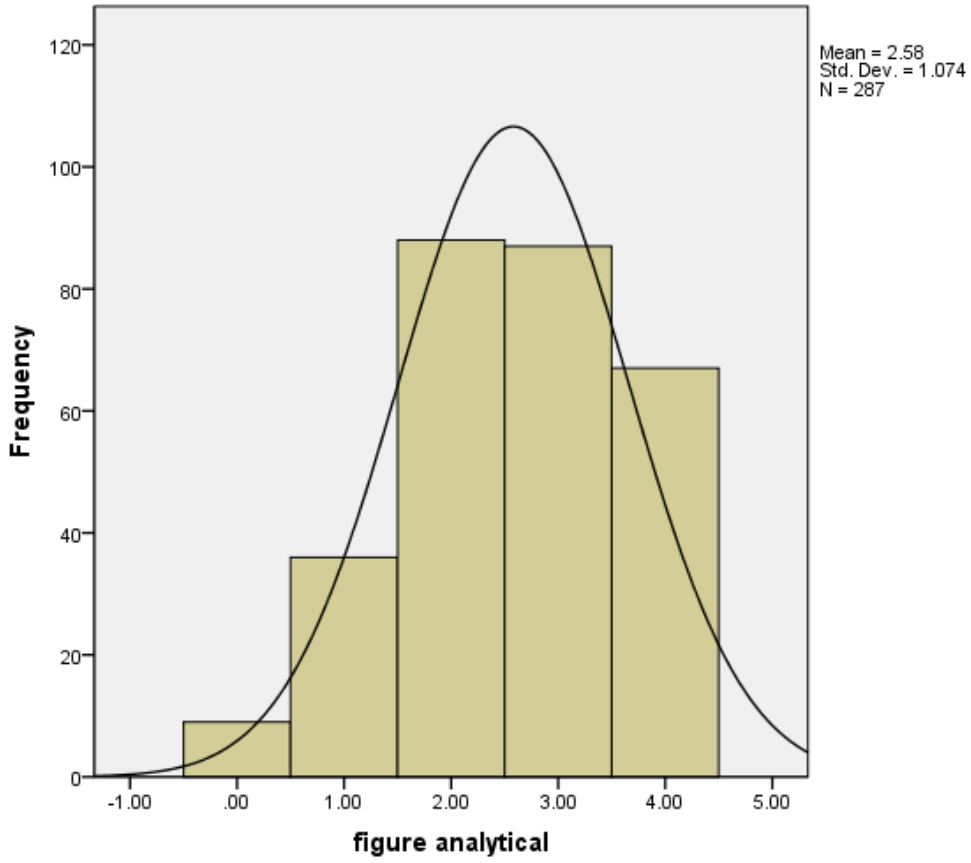


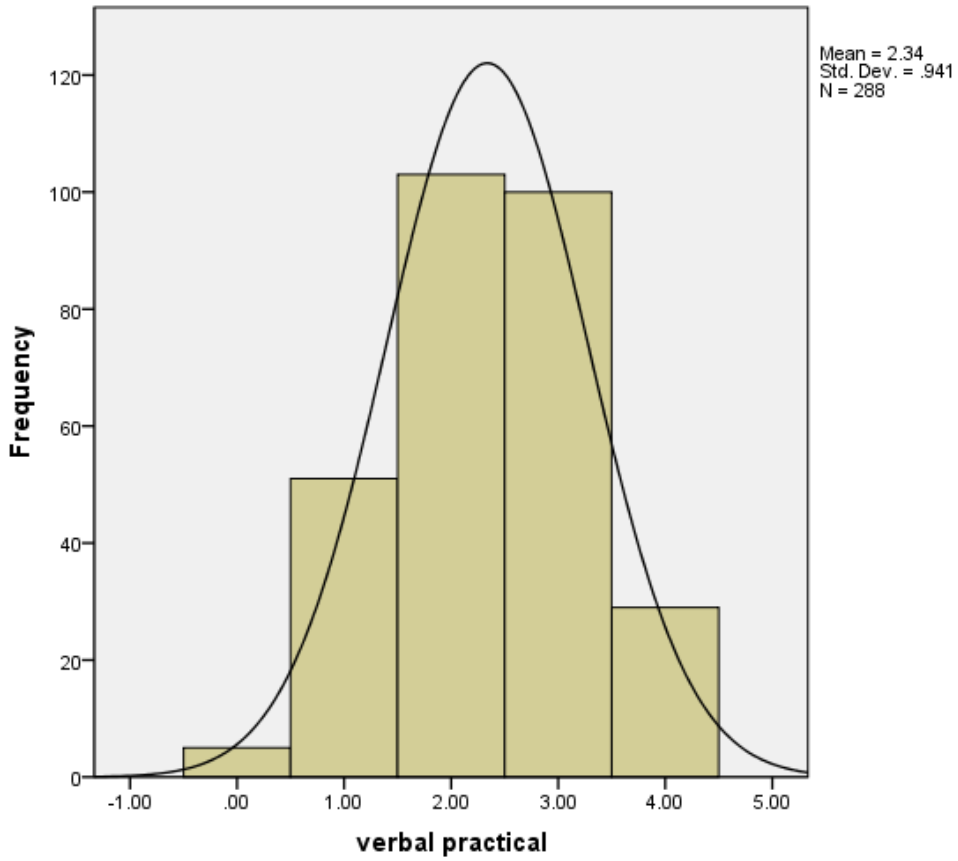


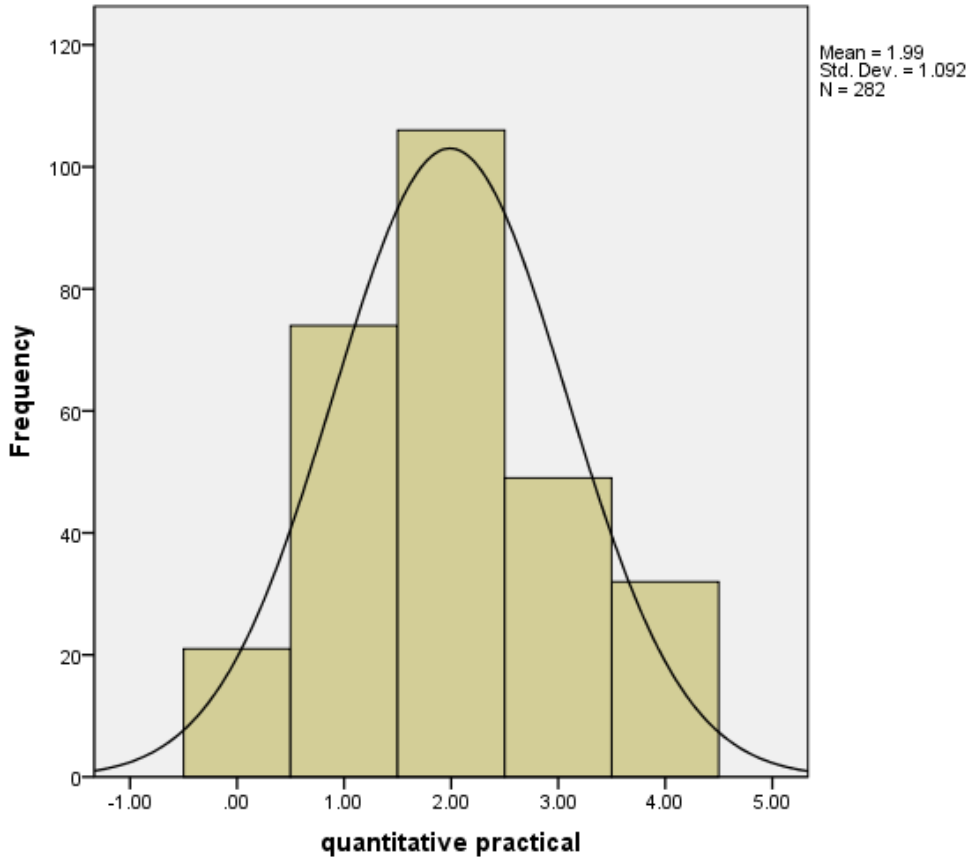

Mean = 99.84
Std. Dev. = 17.232
N = 286
Frequency
60
50
40
30
20
10
0
.00
25.00
50.00
75.00
100.00
125.00
English score

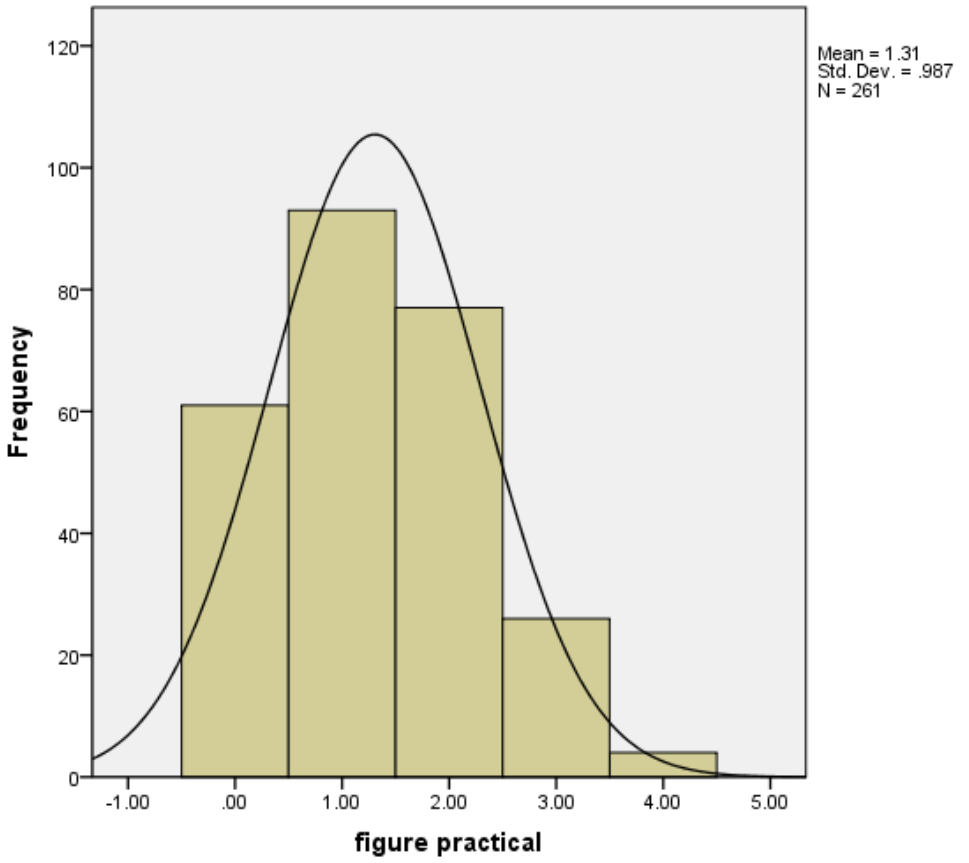

Mean = 2.02
Std. Dev. = .962
N = 288
Frequency
120
100
80
60
40
20
0
-1.00
.00
1.00
2.00
3.00
4.00
5.00
verbal analytical

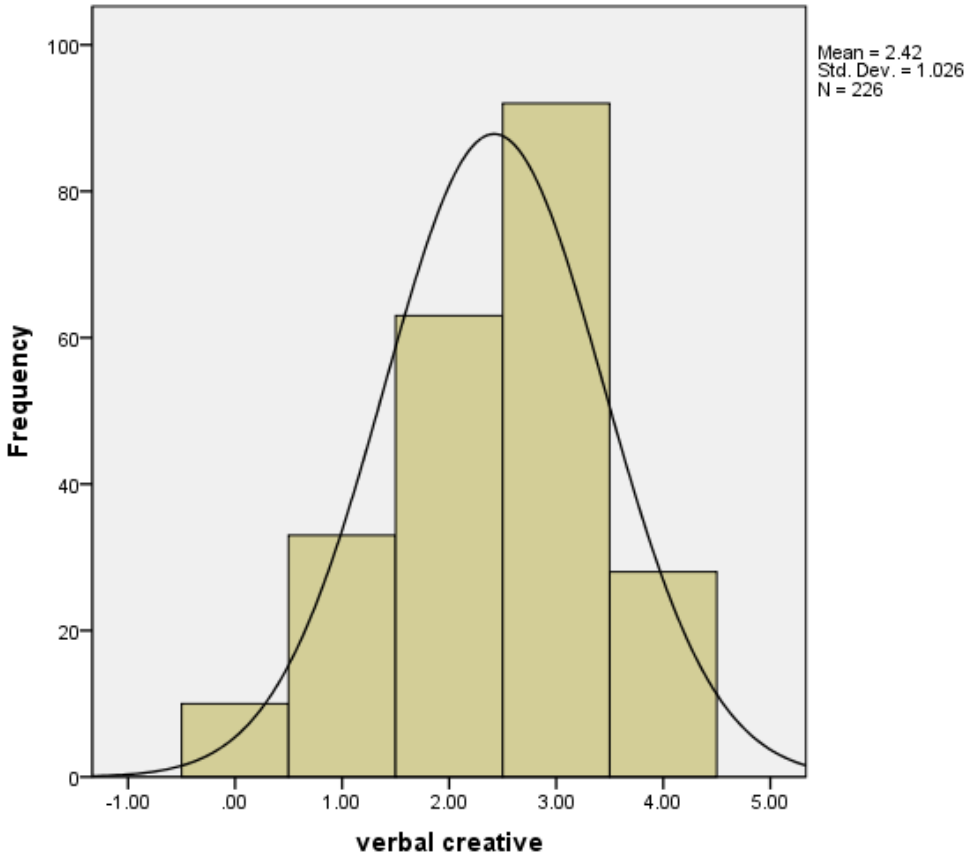

Mean = 2.98
Std. Dev. = 1.09
N = 286
Frequency
120
100
80
60
40
20
0
-1.00
.00
1.00
2.00
3.00
4.00
5.00
quantitative analytical

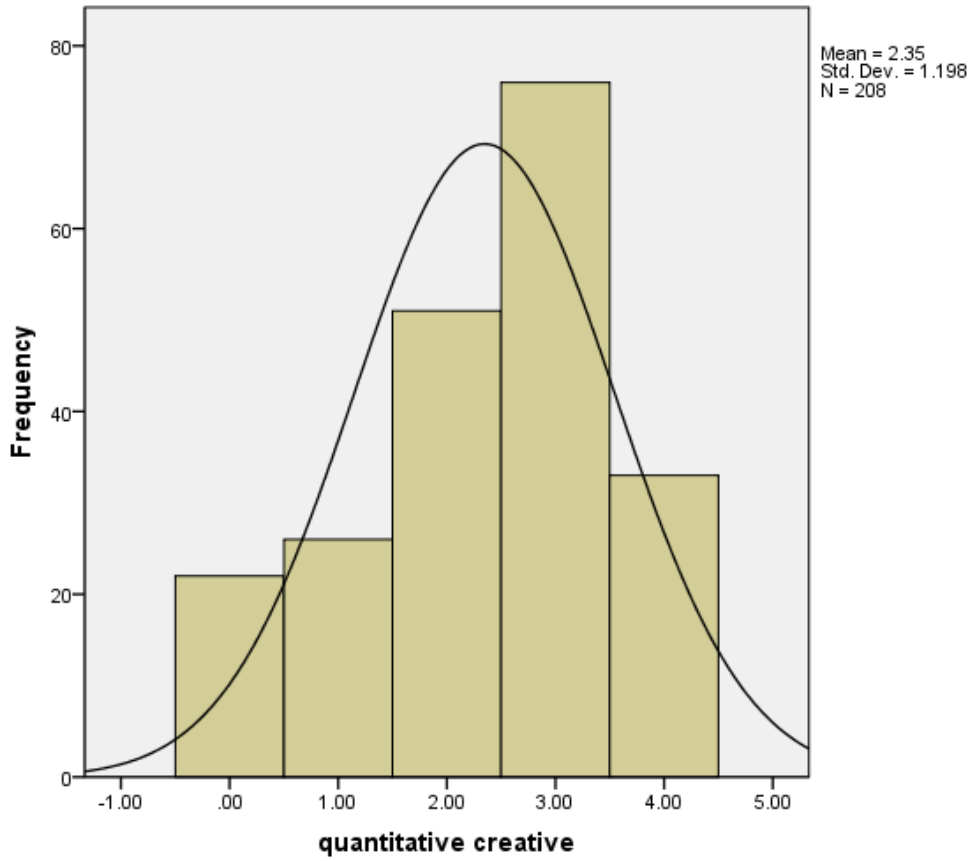

Mean = 2.58
Std. Dev. = 1.074
N = 287
Frequency
120
100
80
60
40
20
0
-1.00
.00
1.00
2.00
3.00
4.00
5.00
figure analytical

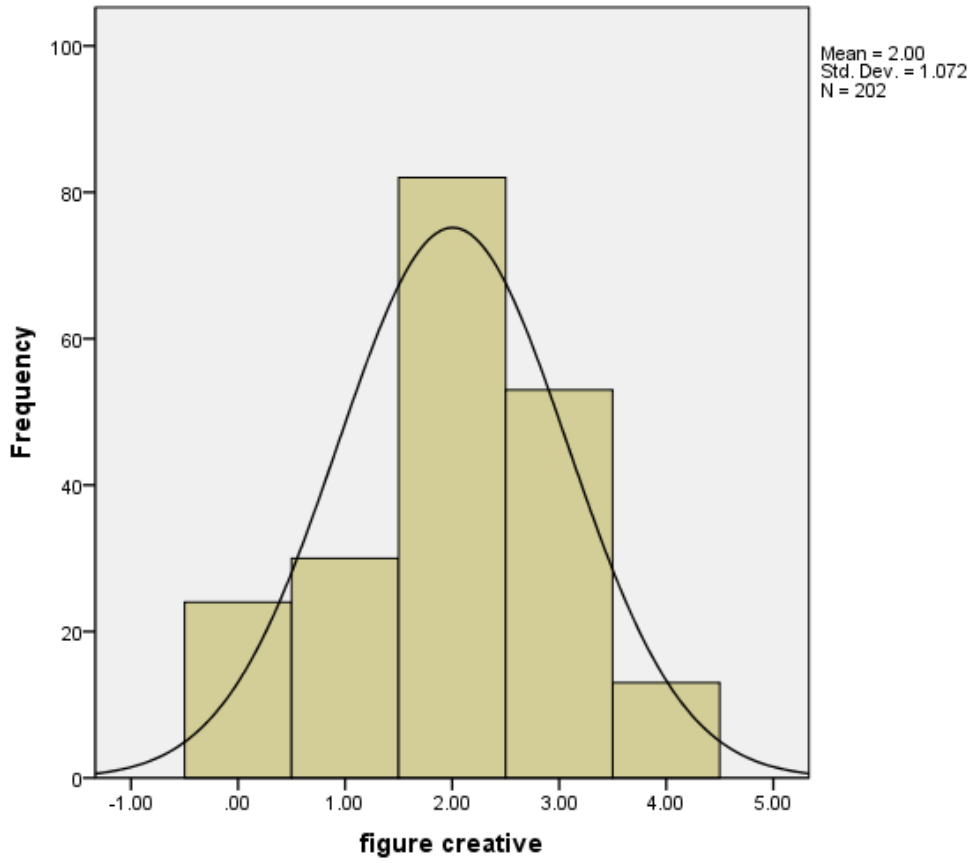

Mean = 2.34
Std. Dev. = .941
N = 288
Frequency
120
100
80
60
40
20
0
-1.00
.00
1.00
2.00
3.00
4.00
5.00
verbal practical


Mean = 1.99
Std. Dev. = 1.092
N = 282
Frequency
120
100
80
60
40
20
0
-1.00
.00
1.00
2.00
3.00
4.00
5.00
quantitative practical


Mean = 1.31
Std. Dev. = .987
N = 261
Frequency
120
100
80
60
40
20
0
-1.00
.00
1.00
2.00
3.00
4.00
5.00
figure practical


Mean = 2.42
Std. Dev. = 1.026
N = 226
Frequency
100
80
60
40
20
0
-1.00
.00
1.00
2.00
3.00
4.00
5.00
verbal creative


Mean = 2.35
Std. Dev. = 1.198
N = 208
Frequency
80
60
40
20
0
-1.00
.00
1.00
2.00
3.00
4.00
5.00
quantitative creative


Mean = 2.00
Std. Dev. = 1.072
N = 202
Frequency
100
80
60
40
20
0
-1.00
.00
1.00
2.00
3.00
4.00
5.00
figure creative

Appendix H Thematic mappings showing how themes were collapsed from codes

Table 7.1. Thematic mappings of why students tended to talk or remain silent

Codes (step 2)	Basic themes (step 3)	Organizing themes (step 4)
concentrate course content use class time efficiently teachers' instructions avoid absent-mindedness keep awake take notes review notes afterwards not missing key information	keep up with lesson	Motives to learn well make students either to talk or listen
know limits clarify thoughts understand deeply Clear correct answers structured organized	understanding	
explain justify analysis deduce reflect break down as a whole links summarize compare connect extend next step	reasoning	
memorize refer back Impressive mark	memorization	
different thoughts unique creative new methods	getting access to diverse ideas	

confident sure know answers high achievement I can unsure about answers worry not dare make jokes	capability	Individual differences play a role in making them either talk or listen. Some students have a sense of self-awareness and tend to self-regulate their learning.
I need I like I prefer I tend I want I am willing I do not want	preference; self-awareness	
good students expectation should do	responsibility	Students were aware of the influence of contexts
short time precious opportunity many students teacher judging limited chances irrelevant to marking	Whole-class learning context	

Note: Codes and themes in black are demonstrated in the transcripts of both talkative and silent students; those in red are demonstrated solely in the transcripts of talkative students; those in blue are shown solely in the transcripts of relatively silent students.

Table 7.2 Thematic mappings showing whether thinking styles affected participation in classroom dialogue

Codes	Themes (thinking styles)
I like I prefer I tend comfortable process information think manipulate	style
unique own ideas my ways	legislative style
follow refer back teachers' instructions take notes	executive style
explain justify analysis deduce reflect break down	judicial style
as a whole links organized	global style
word by word details specific knowledge	local style
resistant to change not adaptable	conservative style
unique creative new methods	liberal style
organized structure manageable	hierarchical style
focused	monarchic style

alone	internal style
independent	
unique to my own	
sharing ideas	external style
communication	
think fast	other styles
think slow	
reflect	

Note: Codes and themes in black are demonstrated in the transcripts of both talkative and silent students; those in red are demonstrated solely in the transcripts of talkative students; those in blue are shown solely in the transcripts of relatively silent students.

Table 7.3 Thematic mappings of the relevance of participation to learning outcomes

Codes	Basic themes	Organized themes
I think so I believe so I guess so of course	self-awareness	Students show self-awareness and tend to regulate their learning.
I can I am allowed choice	self-regulation	Most students perceived to learn well when they participated in dialogue through their preferred ways.
concentrate mastery of knowledge know meet requirement achieve use class time efficiently avoid mind-absent keep awake not missing key information	keep up with lesson and mastery of course content	
clarify thoughts understand deeply clear correct answers organized	understand knowledge better	
thoughtful reflect as a whole links summarize compare extend connections	think critically	
memorize refer back master	Memorization	
score increased achieved developed improved	Scores in the test or examinations show	
not sure	effects depending	effects depending

people think so

Note: Codes and themes in black colour are demonstrated in the transcripts of both talkative and silent students; those in red colour are demonstrated solely in the transcripts of talkative students; those in blue colour are shown solely in the transcripts of relatively silent students.